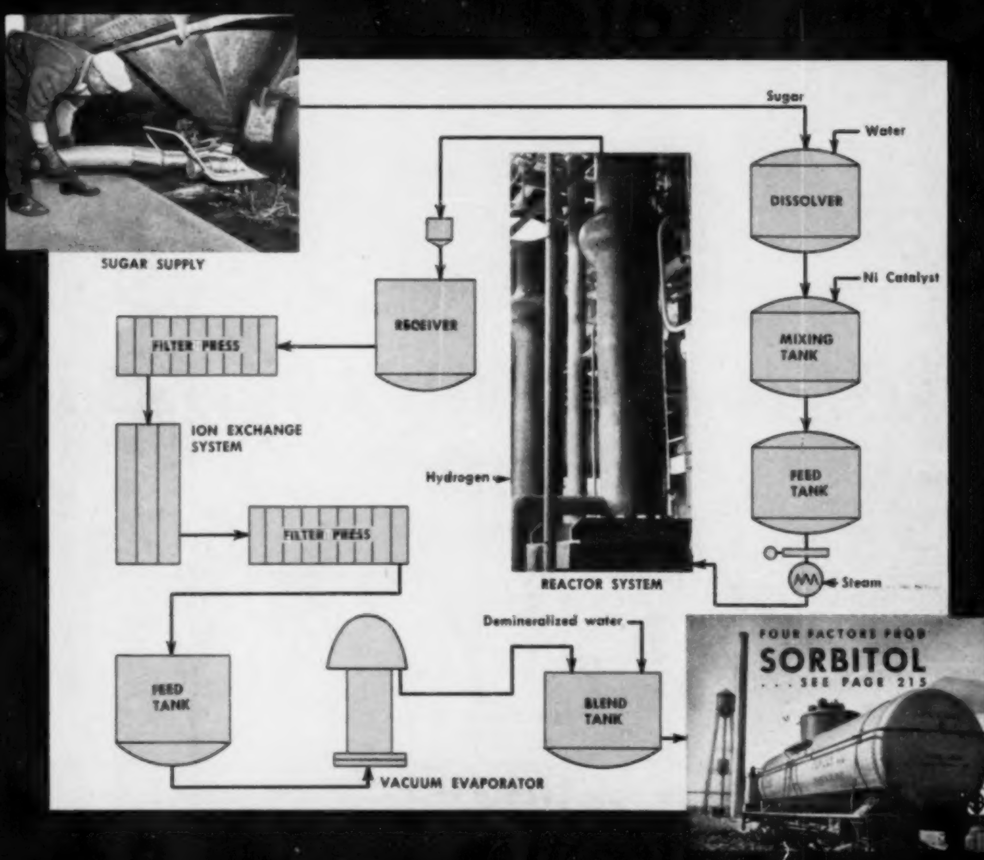
MARCH
1952

Chemical Engineering



A McGRAW-HILL PUBLICATION

FIFTY CENTS

MARCH
1952

Chemical Engineering

WITH CHEMICAL & METALLURGICAL ENGINEERING

PROCESSES AND PRODUCTS

ENGINEERING AND EQUIPMENT

NEWS AND TRENDS

PEOPLE AND FIRMS

LITERATURE AIDS

March 1952 CHEMICAL ENGINEERING Vol. 59—No. 3
Member ABC and ABP

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Now...A Complete **NEW LINE** of Protective Clothing... **NEOPRENE LATEX**

PROTECTIVE CLOTHING

902 — Suit Jacket and 911 Pants

Here's top quality, "strength without bulk" protection against abrasion, acids, alkalis, greases, oils and salt water! It's the companion line in coats, suits, jackets, pants, hats and hoods to AO's new line of Neoprene Latex aprons. The man who *works* in these garments will appreciate their working ease and comfort — the man who *pays* for them will like their cost-cutting durability! Your nearest AO Safety Products Representative can supply you with this new clothing in yellow or black.

QUICK FACTS

SATURATION–COATED FOR LONG LIFE

Five applications of 100% neoprene latex thoroughly impregnate and coat the fabric—plus *two* coats on the outside after sewing. You get a garment that won't peel, blister or crack!

LIGHTWEIGHT — CONTAINS NO LOADERS

Comfort and lightness result from the absence of "loaders" — materials which make a garment stiffer, heavier, bulkier.

MORE FLEXIBLE — UNAFFECTED BY HEAT OR COLD

AO Neoprene Latex remains flexible in extreme cold — does not become sticky in hot weather.

EASIER TO CLEAN

Takes laundering, dry cleaning or scrubbing without injury to fabric. Petroleum solvent may be used.

WORK-STYLED FOR GOOD FIT

All garments are generously cut for free action. Inter-locked seams. Extra heavy stitching. Fasteners securely anchored.

901 — ¾ Length Coat

913 Pants and 922 Hat

9011 One Piece Suit and 921 Hood

American Optical COMPANY

SAFETY PRODUCTS DIVISION

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

AO's Industrial Vision Program increases production, decreases accidents. Write today for free booklet "Improved Industrial Vision."

Another new development using

B. F. Goodrich Chemical *raw materials*

NEW
RIGID PLASTIC TANK CAN'T CORRODE

Made throughout of GEON 404 —no metal used!

HERE'S a new development that shows how Geon 404, a new rigid vinyl plastic, can solve costly problems involving acids and other corrosive elements. The tank is used in a water supply plant. It holds about 20 gallons of hydrofluosilicic acid, used in drinking water to help and protect hardness of teeth.

Naturally, the tank has to be extremely resistant to the highly corrosive acid. And it is, from top to bottom! For the tank, and every nut, bolt and stud in it are made of Geon 404 rigid plastic. No metal is used—no part of this tank can ever corrode.

Geon 404 has advantages that make it ideal for many rigid applications. It possesses all the excellent properties of straight polyvinyl chloride. It can be processed without plasticizer addition on standard equipment, using standard methods.

Geon 404 has outstanding chemical resistance, exceptional strength and excellent electrical properties. At ordinary temperatures it is not affected by acids, alkalies, salts, oxidizing agents . . . or oils, greases, alcohols, gasoline and carbon tetrachloride. Send for Technical Bulletin and helpful advice on the use of Geon 404. Please write Dept. GF-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. In Canada: Kitchener, Ontario. Cable address: Goodchemco.

Geon
Polyvinyl Materials

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

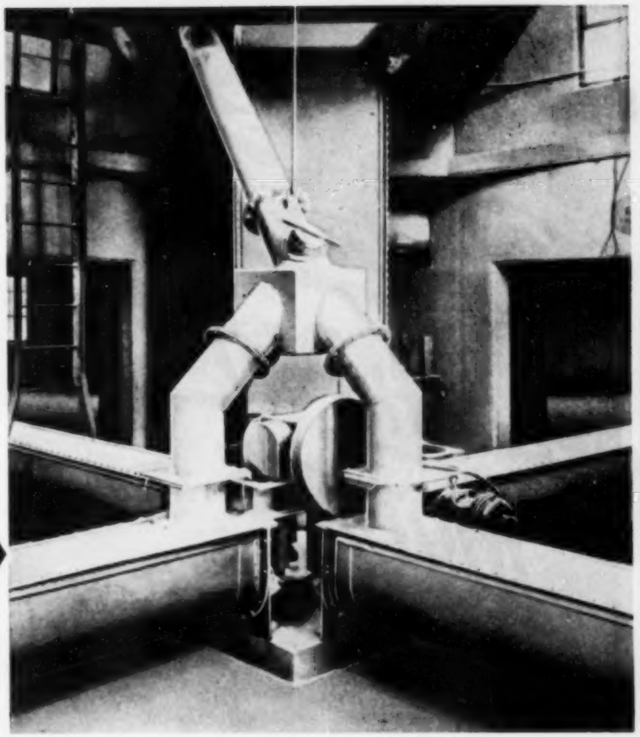
Why LINK-BELT "total engineering" means better screw conveyors for you...

LINK-BELT integrates all components to give you the right screw conveyor for your job

Don't be fooled by the apparent simplicity of a screw conveyor. It *is* simple in design, but there are many important factors that must be considered to give you top performance.

That's why Link-Belt's broad materials handling experience is so important... why Link-Belt Screw Conveyors are first choice on so many demanding jobs. And because Link-Belt makes all types and sizes of components, you get exactly the right screw conveyor for your particular requirements.

It's easy to see why "total engineering" results in top screw conveyor performance. Call the Link-Belt office near you for complete information.

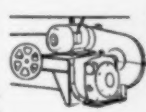


Four Link-Belt Helicoid Screw Conveyors distribute material from Link-Belt Bucket Elevator discharge.

LINK-BELT designs and builds all components!

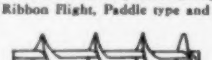
TROUGHS—Link-Belt builds flanged, angle flanged, flared, rectangular, dust-seal, jacketed and drop-bottom types in steel or alloy metals. Variety of connections, supports, covers and clamps offers added design flexibility.

TROUGH ENDS—Steel or alloy metal plate or cast trough ends to match all trough shapes, provide required shaft bearing support and alignment. Seal glands to protect bearings, if required.

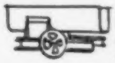


DRIVES: Link-Belt designs and builds many forms of drives to suit specific conditions—enclosed gear, Electrofluid, P.I.V. variable speed, and chain drives of various types.

SCREWS—Link-Belt makes a complete range of conveyor screws—Helicoid, Sectional Flight, Cut Flight, Ribbon Flight, Paddle type and special



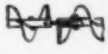
types for such diverse applications as feeding, conveying, mixing, agitating, stirring, blending, etc.



SPOUTS & GATES—Plain discharge spouts can be fixed or detachable. Discharge gates, flat or curved slide, can be hand or rack-and-pinion operated.

Link-Belt can also supply a full range of flanges, thrusts, covers, saddles and countershaft ends

HANGERS—Available in a variety of styles and mountings, with various bearing materials, and steel or cast hanger frames.



SHAFTS & COUPLINGS—Conveyor couplings and end shafts are designed for adequate torsional strength and have jig-drilled coupling bolt holes for accurate alignment.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in Principal Cities.

Only with B. F. Goodrich grommet belts can you make these savings!

Save 3 ways! Investigate today!
Write or mail coupon

You save belt costs because belts last longer, save production costs because machines keep running with fewer interruptions, save maintenance costs because they need less attention.

Patented grommet belts by B. F. Goodrich represent the only basic change since invention of the V belt. Belts last 20 to 50 per cent longer, depending on service. (The more severe the service, the greater the increase over ordinary belts.) Grommet belts have more rubber; they're more flexible, give better grip, less slip.

What is a grommet?

A grommet is like a giant cable except that it's *endless*—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

All cords put to work

Each of the two grommets and every part of a grommet carry their share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. Grommet belts have no center cords, there is no dishing—therefore much more strength in proportion to cord volume—and less stretch. Grommet belts stretch, on an average, only about one-third as much as ordinary belts.

Better grip, less slip

Grommet belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip, there is also less surface wear.

Send for proof

Send the coupon for a set of reports telling users' experiences and showing actual installations where grommet belts outlasted all others. Some typical cases:

"... within a few days ordinary belts had stretched ... After six months of 24-hour-a-day service BFG grommet belts haven't stretched at all ..."

"Ordinary belts lasted only 5 or 6 weeks ... B. F. Goodrich grommet belts are in their sixth month of service ..."

"Previous belts suffered from shock loads, wore out fast ... BFG grommet belts have been in service 2 years with no shut-downs..."

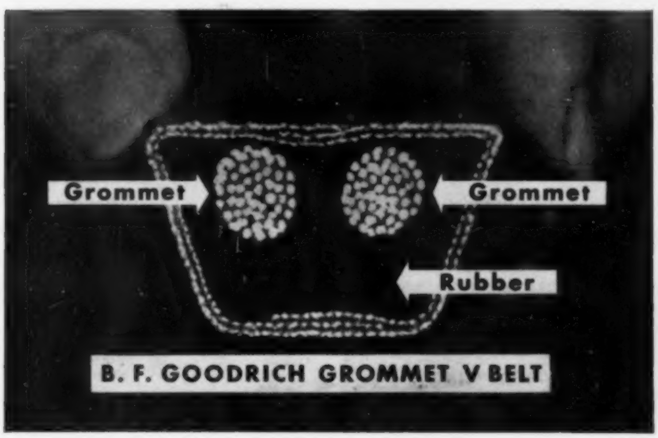
There are hundreds of cases like these.

They cost no more

BFG grommet belts cost not one cent more than others. The savings they make for you are clear profit. They are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent No. 2,233,294).

Write, send the coupon or see your B. F. Goodrich distributor. (He will show you his "X-ray" belt that shows the grommet construction clearly.)

Grommet V Belts BY
B.F. Goodrich
FIRST IN RUBBER



The B. F. Goodrich Company
Dept. CE-3
Akron, Ohio

☐ Send set of reports telling users' experiences and showing actual installations proving that B. F. Goodrich grommet belts outlast all others.

☐ Have distributor show me the "X-ray" belt that shows how B. F. Goodrich grommet belts are made.

Name________

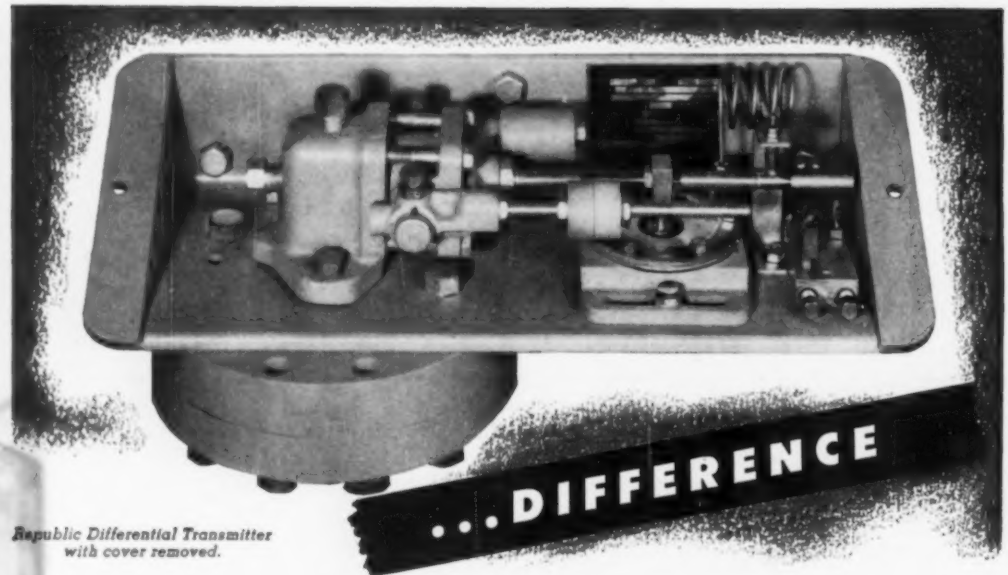
Firm Name________

____

Street Address________

City________

State________



Republic Differential Transmitter with cover removed.

Spells *PLUS* PERFORMANCE

The Republic Pneumatic Transmitter combines machine ruggedness with instrument precision to provide matchless performance in measuring flow, level, pressure or density of a wide variety fluids. By any or all of the following points, the Republic challenges comparison:

ACCURACY of the Republic force-balance principle is higher than can be consistently secured and maintained with any other method. 1/2 of 1% guaranteed.

TEMPERATURE variations of ambient atmosphere have negligible effect on the accuracy of the Republic transmitter.

CHANGES IN AIR SUPPLY PRESSURE do not affect the accuracy of a Republic transmitter to any significant extent. A 5 psi change produces an error of less than 1/10%.

CHANGES IN LINE PRESSURE—Republic differential transmitters are not affected by variations in line pressure. A patented and exclusive simple adjustment assures this protection.

SENSITIVITY—Due to the negligible motions required for complete operation of all parts, for a full scale change, no appreciable hysteresis results from reversal of direction of measurement change.

VIBRATION of any normal frequency has no effect on the Republic transmitter.

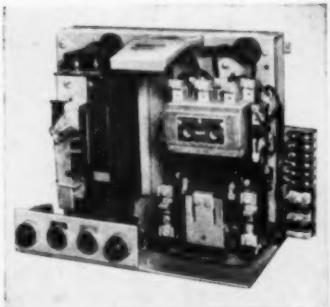
LEVELING—Since all parts are balanced, and no liquid is used for calibration, Republic transmitters need not be leveled exactly, and may be adjusted for installation in any position.

FOR TWELVE YEARS Republic Pneumatic Transmitters have delivered unmatched performance in every type of installation. Complete details of design and operation, plus numerous application suggestions are combined in Data Book, 1002. Send for your copy, today.

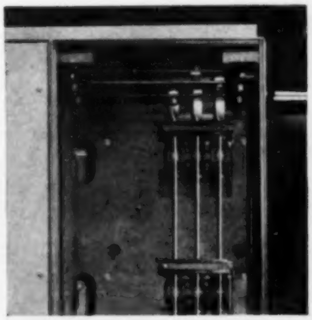
REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

the NEW General Electric Motor Control Center



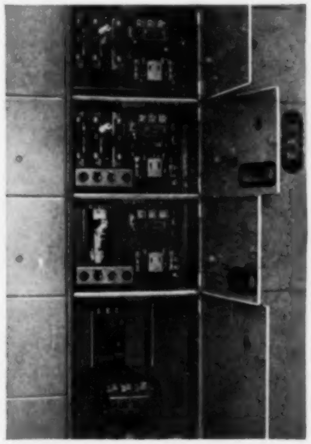
STARTER UNITS ARE COMPLETELY ACCESSIBLE. All components—even the pilot devices—are mounted on a sturdy frame with all terminals front connected.



DESIGNED TO PROTECT PERSONNEL. Rear view shows metal barrier that separates starter unit space from bus bars. Vertical section features new "I-beam" construction for strength.

EASY TO INSTALL AND INSPECT. Sturdy, light-weight starter units are easy to handle, and interchangeable because of standardized dimensions and components.

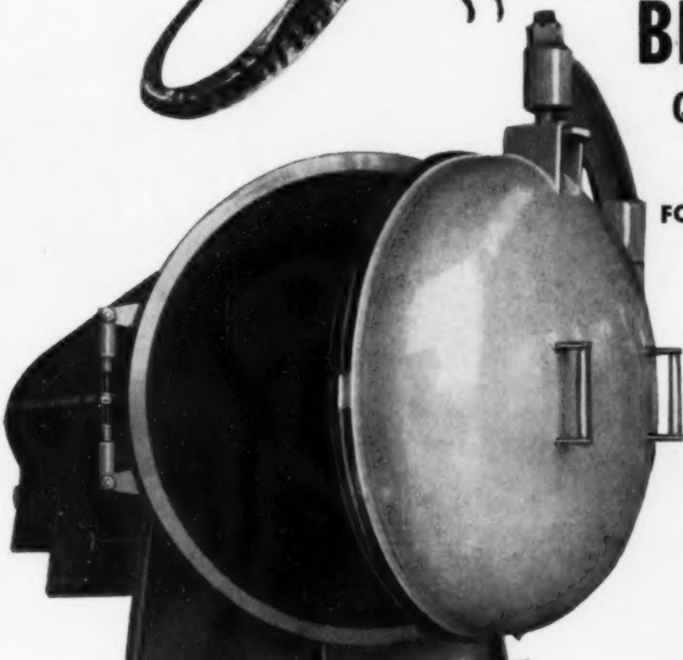
EASY TO WIRE. Ample four-inch wiring trough is completely accessible by removing horizontal metal barriers between units. Barriers isolate and support units as they are slid into section.



VERSATILE. Starter unit sizes and types are in even multiples of 14 inches. Fusible and circuit breaker combinations of the same starter size are interchangeable without changing doors.

EASY TO SERVICE. Doors swing wide (no hinge wiring); unit is easily disconnected from bus and held in test position for protected servicing.

GENERAL ELECTRIC



BLAW-KNOX

QUICK OPENING DOORS

FOR PRESSURE VESSELS

Rim-type ring locks door quickly and securely. Opening is positively sealed by internal pressure. No bolts or lugs.

Blaw-Knox Quick Opening Doors are used extensively on curing chambers, vulcanizers, and similar equipment. Those in use today are made in diameters up to 8 ft. and withstand temperatures to 400° F. and pressures to 300 psi.

FEATURES OF DESIGN

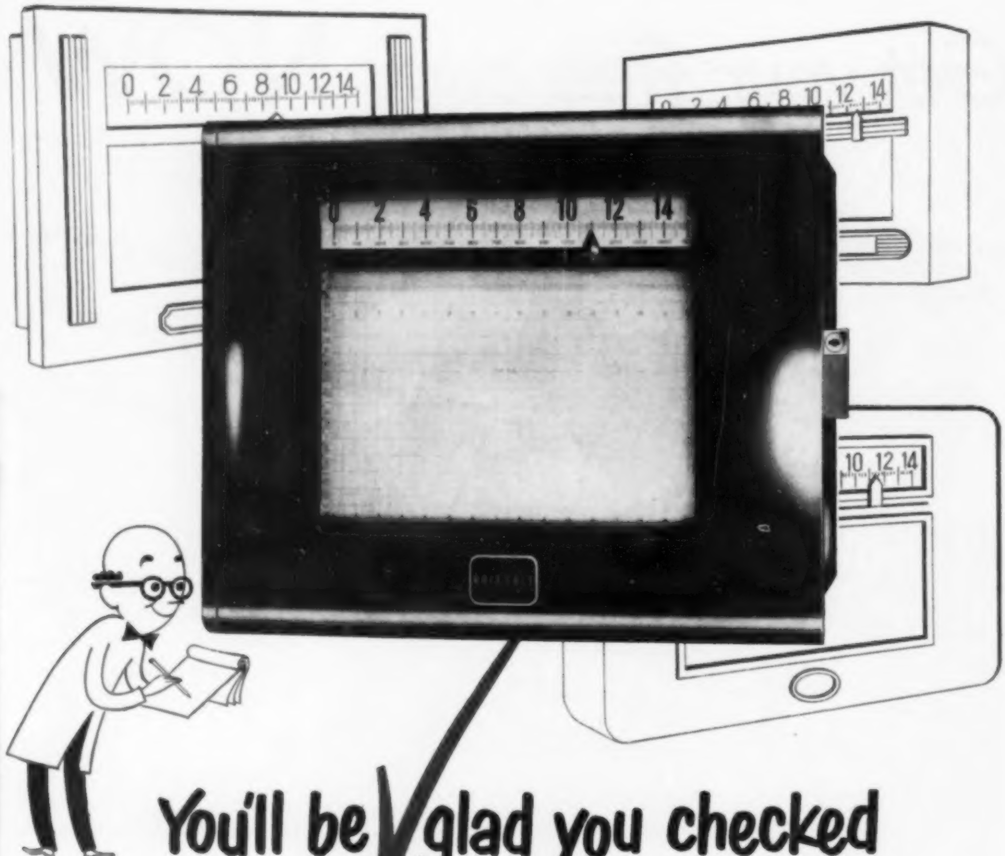
- **Operate mechanically or hydraulically.**
- **No lugs, bolts, levers, or sliding bars.**
- **Self-sealing gasket positively operated by internal pressure.**
- **Smooth functioning ball bearing davit type hinges.**
- **Sections made from rolled or forged steel. No castings.**

May be adapted to either horizontal or vertical vessels.

PROCESS EQUIPMENT DEPARTMENT

BLAW-KNOX

DIVISION OF BLAW-KNOX COMPANY
2090 Farmers Bank Building
Pittsburgh 22, Pa.
Other Offices in Principal Cities



You'll be ✓ glad you checked

BRISTOL'S DYNAMASTER

Continuous-balancing electronic recorders

A high-speed, accurate electronic brain to measure, record, and control d-c voltage, d-c current, resistance, capacitance—or any variable that can be converted into those quantities.

The continuous-balancing circuit responds to minute changes *instantly.*

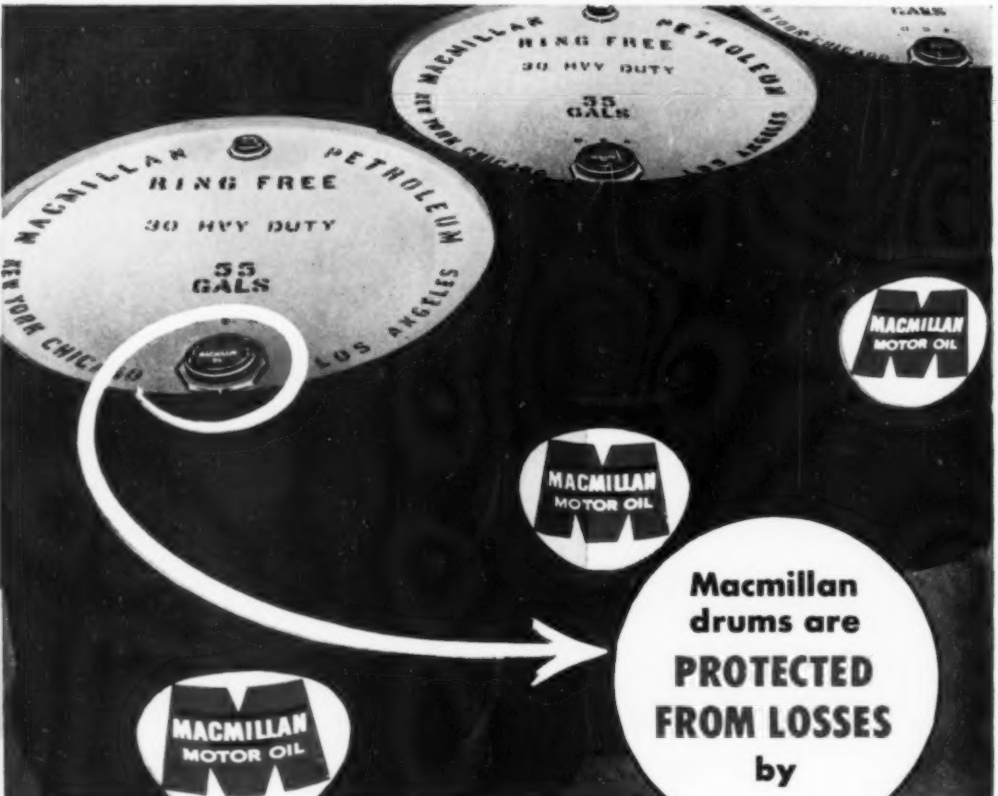
Available as a self-balancing bridge or potentiometer, the Dynamaster is a versatile, dependable, trouble-free measuring instrument.

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

MACMILLAN MAKES SURE
every drum shipment is *safe*



THE Macmillan Petroleum Corporation has built world-wide prestige for its Ring-Free Motor Oils because of its high standards of research and refining. And Macmillan *protects* its prestige by protecting every drum shipment with Tri-Sure* Closures.

Tri-Sure Closures have a Flange, Plug and Seal that keep *all* of the contents inside a drum, and *all* impurities out. They provide 100% security from leakage . . . contamination . . . substitution . . . and undetected pilferage.

Give this protection to *your* product, *your* prestige, and *your* customers' good will—by specifying "Tri-Sure Closures" on every drum order.

Tri-Sure

CLOSURES

**The "Tri-Sure" Trademark is a mark of reliability backed by 29 years serving industry. It tells your customers that genuine Tri-Sure Flanges (inserted with genuine Tri-Sure dies), Plugs and Seals have been used.*

AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Tri-Sure Products Limited, St. Catharines, Ontario, Canada

Production Protected

CHALMERS SWITCHGEAR!

"Any power shut down is costly for us," say Eli Lilly and Company engineers. "It's imperative that we maintain *continuous* electrical service to prevent loss of raw materials and rapid deterioration of products in process." Their answer was 5 kv Allis-Chalmers switchgear to assure dependable circuit protection in their Indianapolis plants.

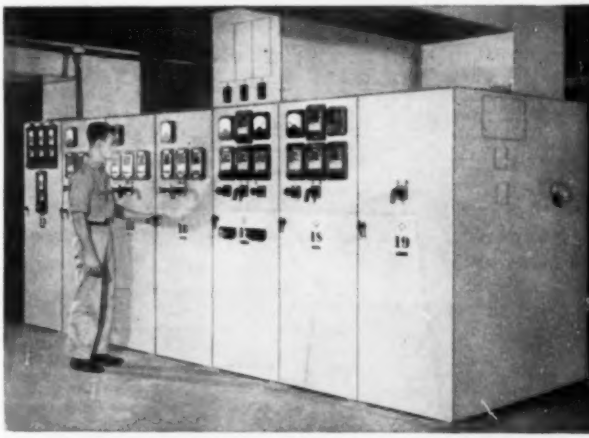
WITH LOSSES LIKE this at stake you can see why Eli Lilly engineers chose Allis-Chalmers switchgear to protect complex filtering, refrigeration, distillation, drying and heating operations.

In streptomycin production, for example, electric power is fed through standard switchgear for every stage of a 72 hour process . . . seeding, growing, fermentation and packaging.

"No maintenance to speak of" that's the A-C high voltage switchgear record at Lilly. 150,000 kva switchgear with *Ruptair* circuit breakers furnishes protection to the McCarty Street plant for liver, insulin and general pharmaceutical production.

At the Kentucky Avenue plant, Allis-Chalmers 250,000 kva, 4160 volt switchgear with oil circuit breakers controls power for production of ampules, antibiotics and general pharmaceuticals.

* * *



5 kv, 1600 ampere switchgear with DZ 100 B oil circuit breakers feeds power to the shipping department and streptomycin section of the Kentucky Avenue plant.

Is *yours* one of the many modern industrial plants that rely on standard Allis-Chalmers switchgear as essential to low cost, continuous plant operation? If not, it will pay you to investigate.

A-C switchgear is flexible. Standard units can be added as your load expands. *It's safe to operate.* Metal-clad construction is dead front for safety to personnel. Interlocks and automatic shutters protect personnel from high voltage parts and make it impossible to move the closed breaker to or from operating position.

Prefabricated, pretested, completely assembled, ready to operate when delivered! Furnished with air blast, oil or *Ruptair* circuit breakers.

See your local Allis-Chalmers sales representative or write for bulletin 71B6129D.

A-3120

Ruptair is an Allis-Chalmers trademark.

Allis-Chalmers
Milwaukee 1, Wis.

ALLIS-CHALMERS

First in the U. S. with Metal-Clad Switchgear


HNO_3
NH_4OH
$NaCl$
H_2O
H_2SO_4
HCl
HEAVY STEEL PLATE
BONDERIZED SURFACE
FORMALDEHYDE-ALHYD-TYPE ENAMEL
THERMOSET VARNISH
THERMOSET VARNISH
FINAL COAT OF GRAY LACQUER

This Chemical Motor has
Uniform Wall Thickness No Weak Spots!

The thinnest part of any motor frame determines how soon corrosion will cause it to fail. The cross-section drawing below shows the difference between Life-Line rolled steel frames and most cast-iron-type frames. Life-Line motor frames have UNIFORM wall thickness at every point—*thicker than the thin sections of most cast-iron-type motor frames.*

PLUS-PROTECTION PROVIDED BY FIVE SPECIAL COATINGS

Five layers of special protective coatings are applied to every Life-Line chemical motor to further inhibit corrosion. These five bands of protection are:

1. *Bonderization on the steel frame*
2. *Formaldehyde-alkyd-type gray enamel*
3. & 4. *Two layers of Thermoset varnish*
5. *Final coat of dark-gray lacquer.*

Combine the uniformly thick walls with these five *plus*-bands of protection and you can see why Life-Lines last longer.

LIFE-LINES DOUBLE LIFE OF CONVENTIONAL MOTORS

Actual field installations show that the Life-Line chemical motor has an extra long service life. Take the case of the motor operating a pump for thyocyanate at a large New England coke plant. The pump splashes the corrosive fluid over the entire motor. Conventional motors lasted a maximum of six months. A Life-Line chemical motor was installed. It has been operating the pump for over a year—and is still going strong. Proof again of longer life.

WANT SOMETHING EXTRA IN A CHEMICAL MOTOR?

Extra protection against corrosion—or outages from any cause? Specify "Life-Line"—they cost no more. Get your copy of Chemical Motor Booklet B-4687 from your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21661

INNER BRACKET THICKNESS

The drawing at the left shows a thin wall section found in most cast-type motor frames. The Life-Line motor frame, at the right, has UNIFORM wall thickness throughout—no weak spots.

YOU CAN BE **SURE**.. IF IT'S
Westinghouse

Life-Line
MOTORS and CONTROLS

AUTOMOTIVE CASTINGS are cleaned continuously with VIRGO Molten Cleaner, a Hooker product.

Metal Producing—Metalworking
... easier with HOOKER CHEMICALS

HOOKER CHEMICALS
used in metal producing, metalworking

VIRGO® DESCALING SALT	Fast, safe, low-cost descaling of stainless and alloy steels.
VIRGO® MOLTEN CLEANER	Fast, safe, low-cost removal of sand and graphite from castings, forgings, fabricated parts.
CHLORINE	Refining aluminum, magnesium, other metals; treating boiler feed water.
CAUSTIC SODA	Desulfurizing steel and wrought iron; reclaiming aluminum.
MURIATIC ACID	Cleaning steels prior to plating; processing titanium, tungsten.
SODIUM SULFIDE	Sulfidizing oxidized lead and copper ores; refining titanium oxide.

METAL INDUSTRIES rely on Hooker for—

- Chemicals that make many jobs faster, easier.
- Shipments that arrive on schedule, in good order.
- Uniform purity that takes headaches out of processing.
- Willing help and advice in use and handling of chemicals.

YOUR INDUSTRY is in this picture, too—

Metal producing and metalworking are just two of more than 30 industrial "customers" served by Hooker as a basic producer of chlorine, caustic soda and chlorinated compounds.

Hooker research has helped many industries bring profitable new products to market, and iron out processing bottlenecks.

If you would like more information on chemicals we can supply to your industry, write today on your business letterhead for General Products List No. 100.

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY

5 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

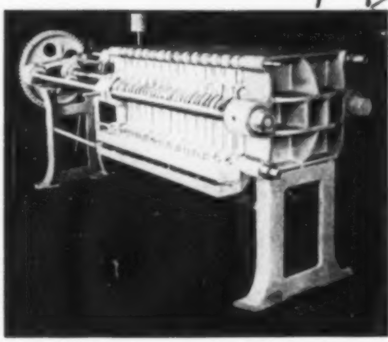
NEW YORK, N. Y. • WILMINGTON, CALIF. • TACOMA, WASH.

HOOKER CHEMICALS ®

2-183

SULFUR CHLORIDES • CHLOROBENZENES • BENZOIC ACID • SODIUM BENZOATE • ALUMINUM CHLORIDE • CHLORINATING AGENTS

it's a tradition



AND QUALITY IS A TRADITION WITH THE SPERRY FILTER PRESS!

Sperry has pioneered and developed the Filter press that today ranks as America's most widely used filter. This definite acceptance of Sperry engineering reflects the *tradition of quality* that for over a half century has set the standard for all Sperry equipment . . . as exemplified in these advantages of the Sperry Filter Press:

Greater Flexibility: Handles any kind of filterable mixture . . . requires less floor space . . . operates on low, medium or high pressure . . . can handle hot liquids without vaporizing . . . Uses filter paper or pulp, wire, wool, asbestos, glass, vinyon and other kinds of simple filter cloths.

Greater Performance: Produces maximum clarity . . . makes the driest cakes . . . can separate emulsions . . . delivers filtrate to higher level than filter . . . leak proof construction . . . can deliver cake in slab form . . . thoroughly washes the cake.

Greater Economy: Low first cost . . . low upkeep . . . low installation cost . . . low depreciation . . . long life.

For specific data regarding your own filtration problem, consult Sperry. Send samples of your material for test run.

SPERRY FILTER BASES

All types . . . all sizes. Plain or punched to your specifications. Besides cotton and paper, bases are furnished in wool, synthetics, glass and woven metals.

D. R. SPERRY & COMPANY
BATAVIA, ILLINOIS

Filtration Engineers for over 60 years

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SPERRY
FILTER PRESSES


IT ALWAYS PAYS TO SPECIFY
LADISH
Controlled Quality
PIPE FITTINGS
...to be sure of sound welds and fast assembly
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16"Std. Ladish © BCR
L
TO MARK PROGRESS
Keeping welding costs down to a minimum and erection schedules on time... these are important advantages you can assure to any piping job by installing Ladish Controlled Quality fittings. Metallurgical controls over materials and methods provide an assurance of uniform weldability in every Ladish fitting... and thorough inspection to rigid standards of physical dimensions and geometric accuracy assures fast piping assembly.
THE COMPLETE Controlled Quality FITTINGS LINE
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POINTING the WAY To Continuing Prosperity

The set of figures in the middle of this page is news of high importance to every American.

In effect, it says that there is no basis in fact for all this talk about a collapse of capital expenditures plunging us into a depression following the industrial build-up for defense.

Such talk assumes that without defense orders business would spend relatively little for new industrial plant and equipment. The figures below show that that assumption is not justified.

BUSINESS PLANS FOR NEW PLANTS AND EQUIPMENT (Millions of Dollars)

	Actual Spending 1950*	Actual Spending 1951*	McGraw-Hill Survey			
			Planned	— Preliminary Plans —		
			1952	1953	1954	1955
Manufacturing	7,491	11,141	12,921	10,028	8,525	8,194
Mining	684	806	943	415	321	358
Railroads	1,136	1,564	1,642	1,248	1,117	1,002
Electric & Gas Utilities**	3,298	3,676	3,948	3,360	3,204	2,748
Other Transportation & Communications	1,392	1,592	1,721	1,671	1,943	1,839
ALL INDUSTRY	14,001	18,779	21,175	16,722	15,110	14,141

*U. S. Department of Commerce
**Electrical World (A McGraw-Hill publication) and American Gas Association.

The figures come from the fifth annual McGraw-Hill survey of business plans for new plant and equipment. Companies were asked to report through that survey not only their plans for 1952, but plans they now have in hand for capital expenditures in 1953, 1954 and 1955, provided the money to carry them out can be obtained.

A Record in '52

As was expected, their plans call for another record-breaking volume of capital expenditures by business in 1952. But, as many did not expect, the McGraw-Hill survey also discloses plans for very heavy capital expenditures in each of the three years following. Expenditures now planned for those years are, to be sure, lower than those planned for 1952. But the significant fact is not that they are lower. Experience shows that plans made several years ahead always overlook many expenditures that are needed later.

The significant fact is that the expenditures already planned for 1953-55 are so high. For example,

those now planned for 1955 would be higher than those of 1950, which, at that time, were second highest in our history.

If these plans are carried out we shall have an essential element of continuing prosperity. Sustained expenditures for capital expansion and betterment account directly for a large share of our employment and consumer income. Moreover, consistent modernization of industrial plant raises production efficiency and brings more and better goods and services within reach of more consumers.

It is not to be expected, of course, that we can come down from the peak of the defense boom without readjustments in some sectors of business. But if capital expenditures by business are carried out on the scale now planned, we shall be able to take any necessary readjustments in our stride, and continue to increase our industrial strength.

From V-J Day to the end of this year, manufacturing industries will have spent over $60 billion for new industrial plant and equipment. This is more than the value of all the plant and equipment these industries had on their books at the end of World War II. It is this heavy outlay that causes some, assuming most postwar plans for industrial expansion and modernization will be completed, to fear a collapse of capital expenditure.

Plans to Go Ahead

But American industry still has plans to go right ahead expanding and improving its facilities. This was the most striking single finding of this year's survey.* It disclosed also that after 1952:

– 83 per cent of the companies answering the survey are planning substantial further modernization.

– 48 per cent will need more capacity to make their present products.

– 33 per cent plan additional capacity to make new products.

It cannot be too strongly emphasized, however, that these plans represent what American industry *wants* to do. They are a concrete expression of hope and aspiration. As such they are extremely important, for they dispose of the idea that business considers the job of expanding and improving its facilities as finished, or anywhere near finished.

But the plans carry no guarantee of accomplishment. If they are to be realized, business must have the funds to carry them out. There is no assurance that the money will be available if the present level of corporation taxes is continued. Eight out of ten companies, according to the McGraw-Hill survey, will rely entirely on profits and reserves to finance their 1953-55 programs. So, in calculating their programs for these years, the companies were asked to assume relief from "excess profits" taxation.

Federal taxes now take at least 52 per cent of a corporation's profits, and 82 per cent of any profits in the so-called "excess profits" bracket. Despite this drain on their funds, companies are able to finance their 1952 programs because (1) they are borrowing heavily, and (2) many of them are getting government loans or special tax concessions on new facilities installed for defense purposes. But these are emergency aids.

Only Two Ways

When the present defense program tapers off, there will be only two ways by which business can possibly increase its principal source of funds for new plant and equipment. One way is to make more profits before the tax collector takes his cut. And the only way many companies, already operating at capacity and high efficiency, can do that quickly is by raising their prices. That is an unpopular method. Also, with the return to more competitive markets, it might be self-defeating.

The other way is for the federal government to release its strangle hold on business profits. The so-called "excess profits" tax – the 82 per cent tax which is really a tax on business growth – should be repealed, effective January 1, 1953. And a cut in the basic tax of 52 per cent on all corporate profits should come not much later. That is by all odds the most important single step toward assuring that business plans already made for capital investment in 1953, 1954 and 1955 are carried out. It is the most important single step toward sustaining our present prosperity.

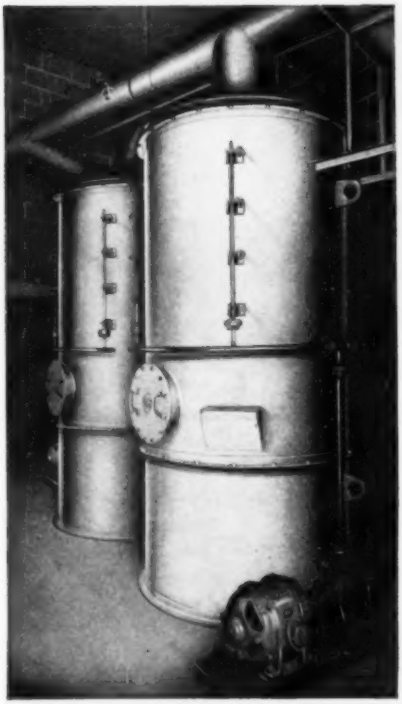
Through its plans for continued expansion and improvement of its facilities, American business clearly points the way to avoid the depression that so many have feared – and the Communists have so ardently hoped – would follow the peak of defense mobilization. It will be a tragedy for our country and for Americans in every walk of life if we do not insist that business get the chance to follow this wise and constructive course.

McGraw-Hill Publishing Company, Inc.

*Note – A copy of the full report of this survey can be obtained by addressing: Department of Economics, McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York 36, N. Y.

DUST and FUME Control

Special equipment engineered to solve individual problems posed by dusts of all kinds, fly ash, chemical fumes, gases of any temperature, aerosols, and other troublesome air polluents



MAHON FOG-FILTERS AT WORK

The installation illustrated above was specially designed for the Motor State Oil & Grease Co., Jackson, Mich. PROBLEM: To eliminate H_2S odor from sulphonated grease manufacturing operations. The problem was complicated by grease and oil fumes present in H_2S gas. SOLUTION: A two-tower Fog-Filter connected in series was designed with high pressure water fog collecting practically all of the grease and oil fumes in the first tower. A caustic solution employed in the second tower and fogged at lower pressure removes the remaining H_2S from the air before it is exhausted into the atmosphere.

In dealing with air contaminants, each individual air cleaning problem must be approached with a view to determining what type of collector or filter is required to produce maximum results under existing conditions. Study and analysis of the character and extent of the polluent is therefore imperative in arriving at a satisfactory solution. Mahon dust and fume control engineers have, over a period of years, developed and perfected special Wet and Dry Collectors and Fog-Filters which have proved highly successful in coping with all types of industrial air contaminants—a few are illustrated here . . . they are serving today in some of the most difficult and mandatory air cleaning jobs in industry. Each installation has been engineered to do the specific job. If you have an air pollution problem, regardless of its character, it will pay you to call in a Mahon engineer and let him show you what Mahon equipment has done with like polluents under conditions comparable to your own. See Mahon's Insert in Sweet's Mechanical Industries File for further information, or write for Industrial Equipment Catalog A-652.

THE R. C. MAHON COMPANY

Main Plant and Home Office, Detroit 34, Michigan

Engineers and Manufacturers of Dust and Fume Control Equipment Including Cyclone Collectors, Hydro-Foam Collectors, Jet Trap Collectors, Hydro-Filter Collectors, and Fog-Filters and Cupola Stack Washers.

All Mahon Equipment is Erected by Mahon to Insure Complete Satisfaction.

Fog-Filter

Hydro-Foam Dust Collector

Jet Trap Dust Collector

MAHON

Stewart-Mowry blending manifold carrying naphtha, oils, driers and paint chemicals. Manifold is piped with Nordstrom Fig. 3402 valves. Three-way Nordstrom valves control lines feeding manifolds.

Fred N. Gundrum, Stewart-Mowry President, with one of plant's product brands.

TWO-YEAR STUDY CONVINCES STEWART-MOWRY PAINT COMPANY

Nordstrom Valves Best for Naphtha, Varnish, Driers, Oils, etc.

In a paint plant, leaking valves are hard to prevent. The chemicals and oils used in paint making are often erosive, corrosive, and hard to hold.

Tired of the problem, the Stewart-Mowry Company, Chicago paint manufacturer, ran a two-year test of many types and makes of valves.

Valves were installed in all kinds of services—on lines carrying liquids of such varied density and viscosity as cobalt drier, mineral spirits, varnish, raw oil, linseed oil, tung oil, naphtha and driers.

The test ended December, 1951. The results? . . .

Says Stewart-Mowry President Fred N. Gundrum: "Nordstrom valves were by far the best all-around valve for these liquids. They absolutely eliminated our leakage and clean-up problem. In lines where we had been replacing ordinary valves every few months Nordstrom valves are operating with no maintenance except for routine lubrication. They have not only cut replacement costs, but have simplified plant housekeeping and consequently increased safety."

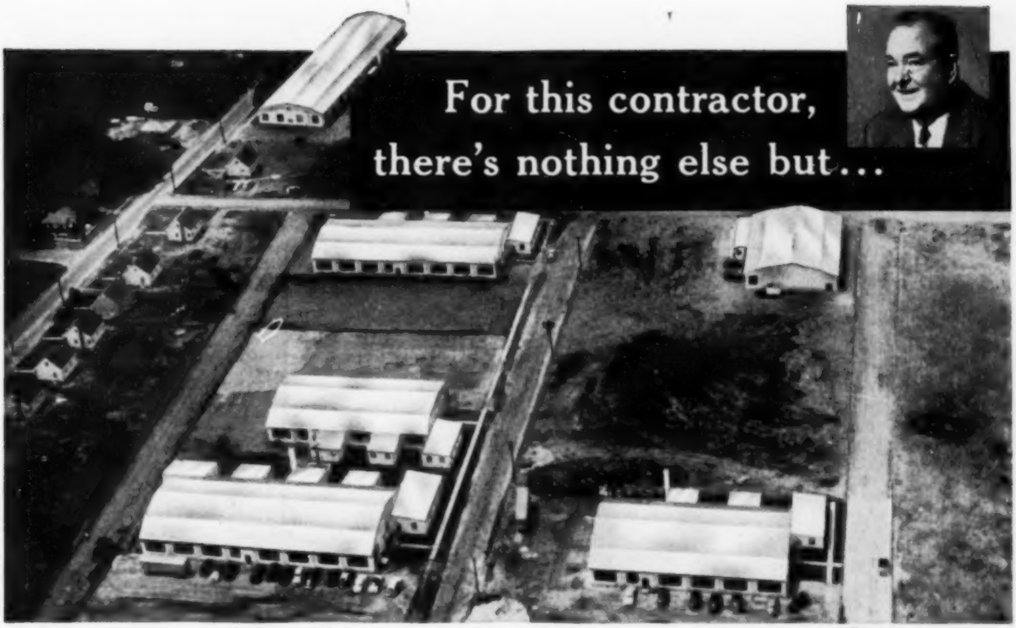
Stewart-Mowry is now replacing ordinary valves throughout the plant with Nordstroms. Perhaps, in their experience, there are savings for you in *your* plant's process lines. Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

Rockwell Built

Another Product

Nordstrom Valves

Lubricant Sealed to Keep Upkeep Down

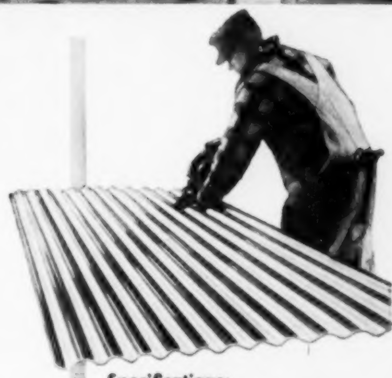


George Mole has been a contractor and industrial building owner in the Amityville, Long Island, area for 25 years. He discovered Reynolds *Lifetime* Aluminum Industrial Corrugated in 1949. He put his first 15,000 square feet on the Amityville School ... then used it on the Copiague and Lindenhurst schools and on 13 other industrial and commercial buildings. Let him tell you why:

"First of all economy. Initial cost is low. The insulation value means still more economy, as well as more comfort inside. Low maintenance and long life extend economy through the years. And lighter weight (56 pounds per square) can save on construction.

"My Reynolds .032 roofs have set a standard in this area that I am proud of. I have more buildings planned, and if I can't get this roofing I won't build — that's how sold on Aluminum I am."

Call Reynolds for literature and technical assistance ... offices in principal cities. Check your classified phone book for our listing under "Building Materials" or write to Reynolds Metals Company, Building Products Division, 2042 South Ninth Street, Louisville, Kentucky.



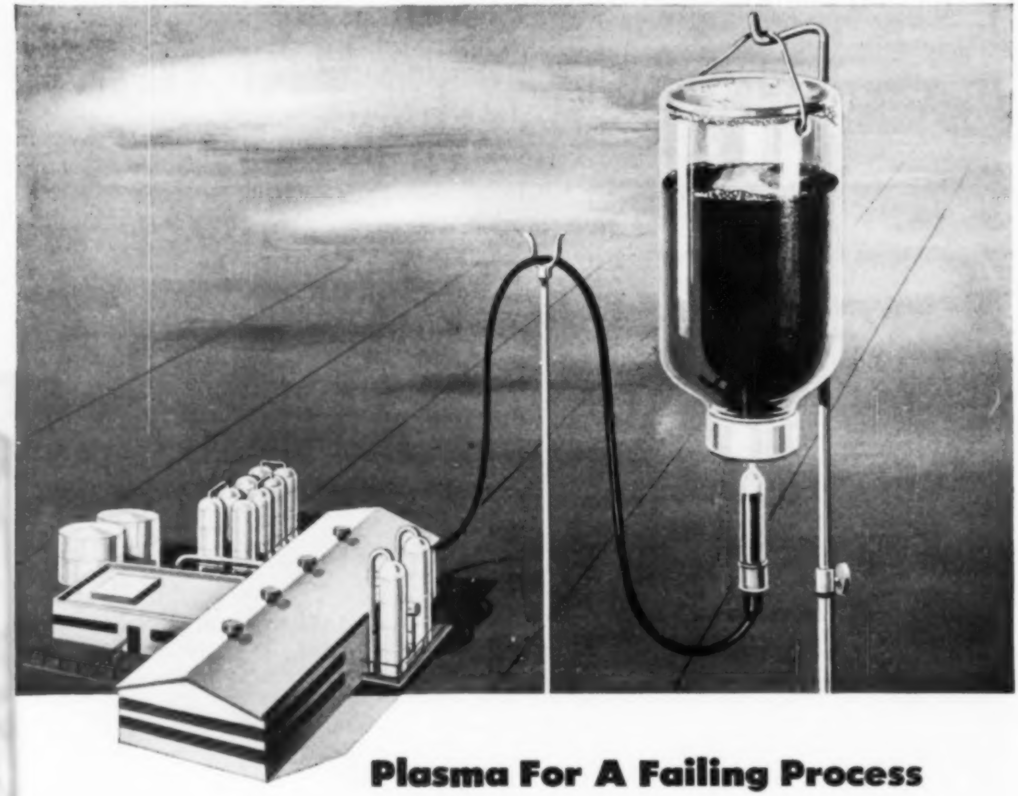
Specifications:

- Thickness .032"
- Corrugations 7/8" deep, 2-2/3" crown to crown
- Uniform load support (roof) 80 p.s.f. on 4' purlin spacing
- Roofing width 35", coverage 32"
- Lengths 5', 6', 7', 8', 9', 10', 11', 12'

Military demands for aluminum reduce supply, but Reynolds is rapidly expanding aluminum capacity. Rated orders receive priority handling.

REYNOLDS *Lifetime* ALUMINUM INDUSTRIAL CORRUGATED

"The Kate Smith Evening Hour" on Television, Wednesdays—Tallulah Bankhead in "The Big Show" on Radio, Sundays—NBC NETWORKS



Plasma For A Failing Process

Throughput usually suffers when any part of your process gets too weak to keep up with the rest of your system. Here's how one company we know prevented such a problem.

Chlorinated hydrocarbons for use in plastics had to be weighed. Test-tube accuracy without metallic pick-up, contamination or discoloration was essential. Stability had to be maintained with sub-zero temperatures.

The answer: jacketed weigh tanks on suspended scales. Passage between shells gave ample circulation for coolant, while a nickel-clad steel inner shell assured purity, gave fast, uniform heat transfer. Easy low-cost maintenance and long life also resulted.

Where did this solution come from? It was the result of cooperative development between the engineering staffs of progressive Equipment Builders, process engineers and materials suppliers. In developing such equipment, these *better* builders regularly turn to Lukens for its knowledge of materials, as well as its wide range of low-cost clad steels.

Even with new equipment hard to get, these builders can often recondition what you have for better, more profitable production. For their names, write us today, explaining your problem. Manager, Marketing Service, 400 Lukens Building, Coatesville, Pennsylvania.

LUKENS

AID DEFENSE MORE SCRAP TODAY... MORE STEEL TOMORROW

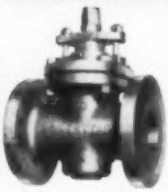
LUKENS STEEL COMPANY

WORLD'S LEADING PRODUCER OF SPECIALTY STEEL PLATE · PLATE SHAPES · HEADS · CLAD STEELS

WE MAKE ALL TYPES OF PLUG VALVES
For *ALL* Kinds of Services
In the Right Metals for Your Needs

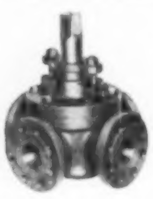
HOMESTEAD
Lever-Seald
Quarter-Turn
PLUG VALVE

HOMESTEAD CAM-SEALD
(dry seat)

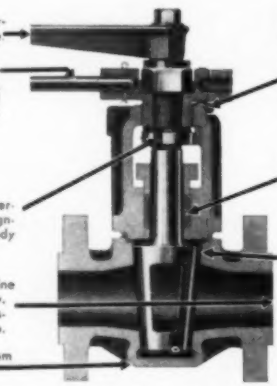


Straight-way—
Flanged or Screw Ends

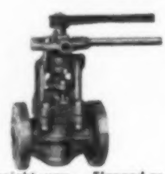
Three-way—
Screw or Flanged Ends



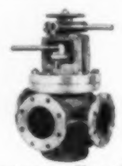
Four-way—
Flanged or Screw Ends



Sectional View — Homestead Lever-Seald Valve — Closed Position



Straight-way— Flanged or Screw Ends



Three-way— Flanged or Screw Ends

Four-way— Flanged or Screw Ends

HOMESTEAD-REISER
(lubricated)

Straight-way—
Screw or Flanged Ends

Straight-way—
Worm & Gear Operated

Flow Changer—
Non-lubricated

You can end valve-operating difficulties on high temperature, pressure and corrosive services, and on jobs where lubricant would contaminate process fluids, by installing Homestead Lever-Seald Valves. They are stick-proof, because a *built-in* lever and screw device assures positive action at all times, under all conditions. If the service warrants, they may be double-sealed by pressure gun lubrication.

Homestead Lever-Seald Valves are available in straight-way, three-way, and four-way types, with screwed or flanged connections. They may be cast in Semi-Steel, Steel, Ni-Resist, Stainless Steel, Monel, or other alloys; in sizes from 1" to 10"; for vacuum to 1500 lbs., and for temperatures from 40° below zero to 1100°F. For full information, write for Valve Reference Book No. 39-3. No obligation.

Distributors in all parts of the world. For local representative see Classified Telephone Directory.

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 13 "Serving Since 1892" **CORAOPOLIS, PA.**

To get maximum tube life per dollar... Ask the experts!

THERE'S only *one* high temperature tube steel that can give you maximum tube life per dollar—the best life/cost ratio—under a particular set of heat, pressure, corrosion and oxidation conditions.

To make sure you get the right steel, go to the metallurgists of The Timken Roller Bearing Company. They're recognized authorities on high temperature steels. With 20 years experience in research and with 23 different analyses at their disposal, they'll help you select the one best steel for your operating conditions. And you're assured of uniform, high quality steel in every tube because of the Timken Company's rigid quality control from melt shop through final tube inspection.

Let our "RSQ"—Research, Supply, Quality—solve your tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

This month's report is on:

DM STEEL

Has unusually high creep strength for a pearlitic steel, good stability up to 1200°F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

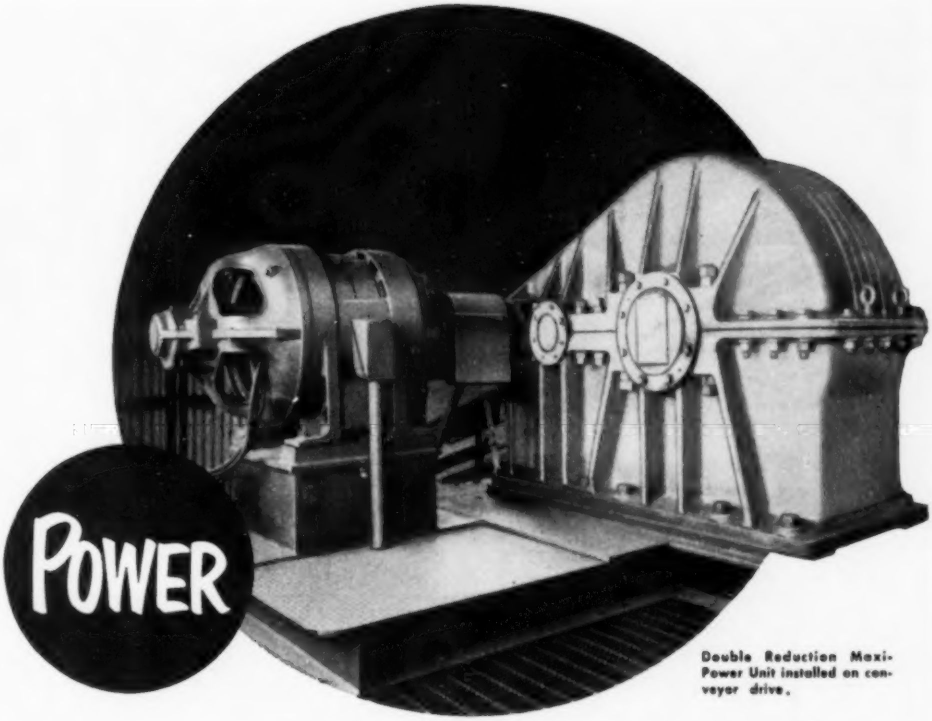
23 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

Pictured above is a direct-reading spectrometer, used in the Timken Company's Spectrographic Laboratory. It chemically analyzes a molten heat of Timken steel in just 40 seconds, makes possible precise control of the steel's properties.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



Double Reduction Maxi-Power Unit installed on conveyor drive.

in minimum space with *Maxi-Power* parallel shaft drives

For heavy-duty applications, here is a drive that offers the maximum in sturdy, reliable service.

Precision generated helical gearing with uniform load distribution across the entire face means improved performance — permits maximum load-carrying capacity in minimum space.

Maxi-Power Drives are available in single, double and triple reductions in ratios from 2.08 to 1 up to 360 to 1 — capacities up to 1,550 h.p.

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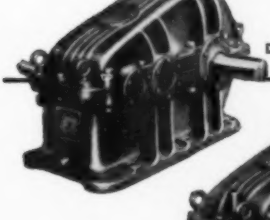

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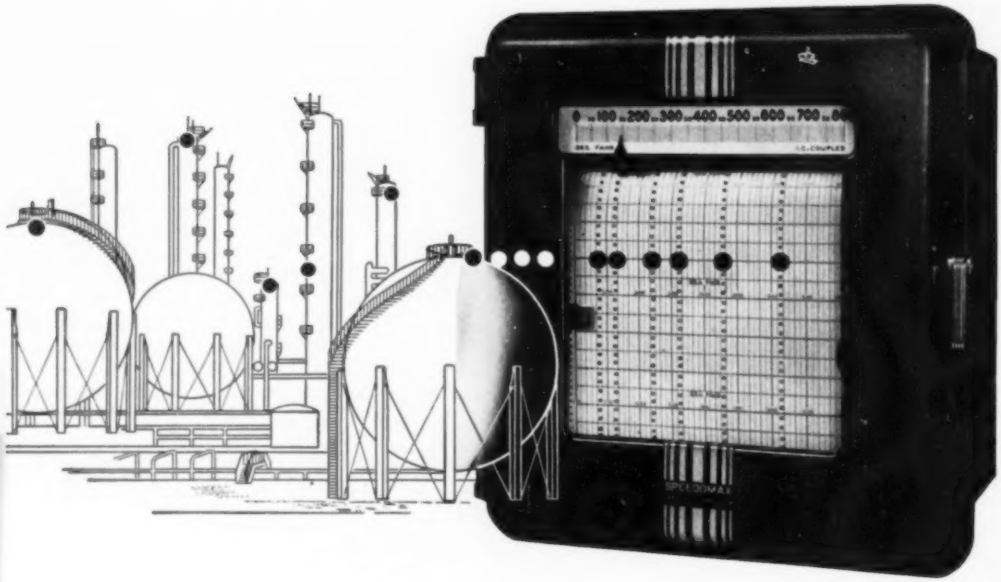
TRIPPED!
Now . . . another great development by Dodge . . . that provides instant and positive protection for driven machines, motors, and the famous Torque-Arm Speed Reducer itself! The new Dodge Tri-Matic Overload Release prevents breakdowns, avoids expensive repairs, insures your production against costly interruptions.
Here's a worthy companion to other Dodge achievements in power transmission machinery, such as Taper-Lock Sheaves, Dodge-Timken Bearings, Rolling Grip and Diamond D Friction Clutches. Dodge Torque-Arm Speed Reducers, which have brought dependable speed reduction to industry's machines at great savings in cost, are available in two series—Single Reduction and Double Reduction—with capacities from 1 hp to 43 hp, speeds from 18 to 330 rpm.
Write for special data on Torque-Arm Speed Reducers and the new Tri-Matic Overload Release.
CALL THE TRANSMISSIONEER
DODGE MANUFACTURING CORPORATION, 200 Union St., Mishawaka, Ind.



A new temperature Fact every 2 sec!

Today, when many refinery operations may need temperature facts within seconds instead of minutes, the Speedomax story is worth knowing:

For a Speedomax Multiple-point instrument's record-printing "wheel" darts from temperature to temperature in just 2 seconds per point! Thus, if there are, say, 15 fairly important temperatures on a single refinery unit, each one can actually come up and be recorded as often as twice per minute, automatically and continuously.

Two extra checks for vital temps

But suppose a few points require even closer watching, or more frequent recording? Speedomax handles them, too, in either of two ways:

First, they can be recorded more frequently than the other points, in such a sequence as 1, 2, 1, 3, 1, 4, etc.

Second, the vital points can be recorded in greater detail than the other points. This is done by giving the instrument an additional range which is used only with the pre-selected points. This range puts far fewer degrees-per-inch across the instrument's scale; it thus "spreads" the reading for detail.

Ability to measure temperature from any source and across either wide ranges or the new narrow ranges is another L&N specialty. Selection among thermocouples, Thermohms and Rayotubes will determine the correct sensing element. Selection among various recorder components will put the information on paper in the desired form.

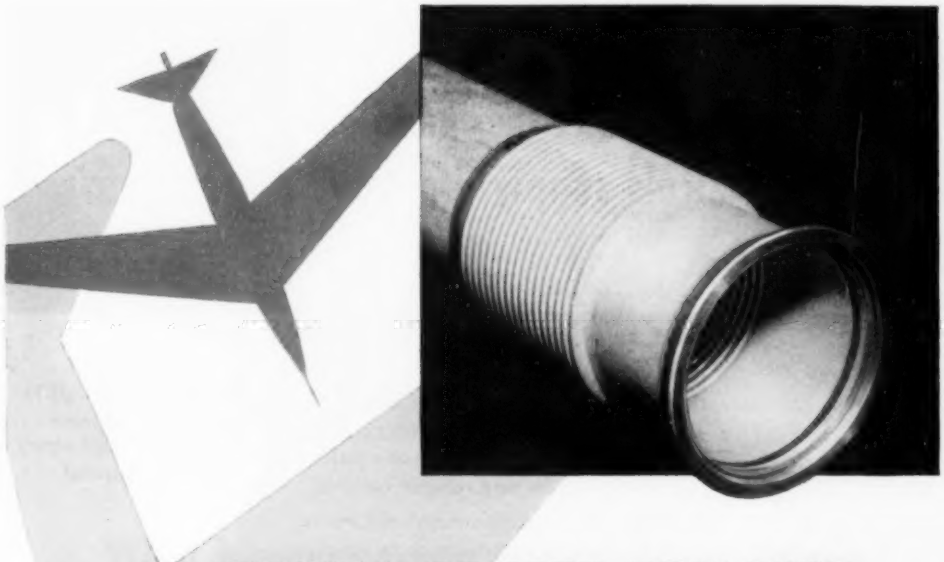
160 temps on one instrument

For these and many more features . . . for instance, 160-point models . . . credit Speedomax's refined, stable, dependable construction, both electrical and mechanical. Too, Speedomax is not affected by vibration; never needs levelling up; can measure many quantities besides temperature.

Any L&N office, including 4916 Stenton Ave., Phila. 44, Pa., will send the Speedomax story on request.

LEEDS & NORTHRUP

Jrl. Ad. ND46-700(2)



ENDURO DE-ICER BELLOWS

breathe 600° air

Ice-melting air surging through aircraft de-icer ducts gets as hot as 600-degrees F. Outside temperatures may go plenty below zero. Ducts expand, contract, expand again. But, accordion-like bellows assemblies—made of Republic ENDURO Stainless Steel—literally "breathe," compensating instantly for dimensional changes.

Here, 600-degree temperatures don't affect ENDURO Stainless Steel. ENDURO resists heat. Resists corrosion. Resists rust. Serves long and faithfully despite continued flexing at high temperature.

Similar ENDURO bellows are fighting heat and corrosion throughout the chemical process industries. Their use for take-up tubes in ammonia lines is a good example.

What jobs have you for ENDURO? Republic—world leader in production of alloy, stainless and heat-resisting steels—offers you the immediate services of capable metallurgical and technical staffs on any problem involving current or potential uses of stainless steels.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Republic
REPUBLIC STEEL
ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels—Pipe, Sheets, Bolts and Nuts, Tin Plate, Tubing, Niles Barrels and Drums

Where industry has the "need" Oronite Chemicals supply the way

ORONITE CHEMICAL COMPANY
THE NAME TO WATCH IN CHEMICALS

ORONITE was the pioneer in the development of a chemical called "Polybutenes." Today, industry looks to Oronite as a major source of this very versatile chemical.

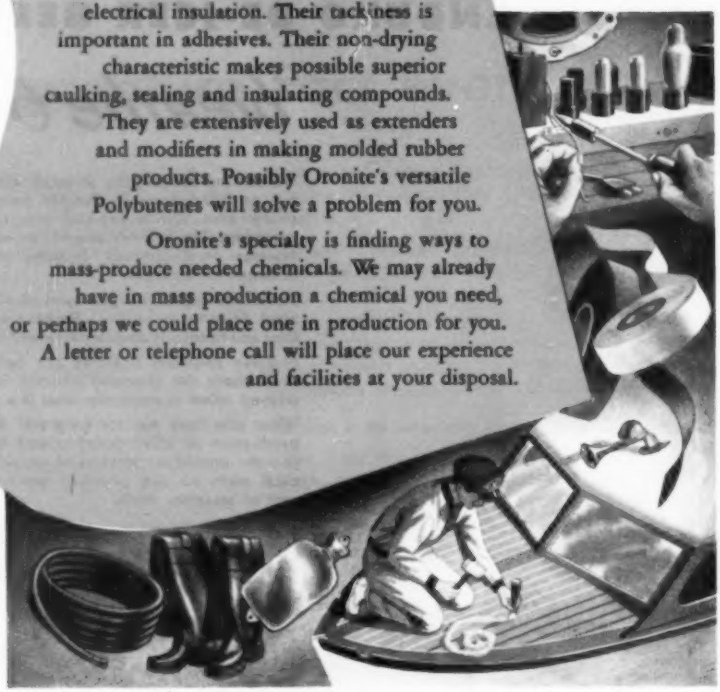
The high dielectric strength of Oronite Polybutenes makes them useful in electrical insulation. Their tackiness is important in adhesives. Their non-drying characteristic makes possible superior caulking, sealing and insulating compounds. They are extensively used as extenders and modifiers in making molded rubber products. Possibly Oronite's versatile Polybutenes will solve a problem for you.

Oronite's specialty is finding ways to mass-produce needed chemicals. We may already have in mass production a chemical you need, or perhaps we could place one in production for you. A letter or telephone call will place our experience and facilities at your disposal.

Most
ORONITE PRODUCTS
are available now—
some are in short supply
Please inquire!

A partial list of
ORONITE PRODUCTS

Detergent Alkane
Detergent Slurry
Detergent D-40
Detergent D-60
Wetting Agents
Lubricating Oil Additives
Cresylic Acids
Gas Odorants
Sodium Sulfonates
Purified Sulfonate
Naphthenic Acids
Phthalic Anhydride
Ortho-Xylene
Para-Xylene
Xylol
Aliphatic Acid
Hydroformer Catalyst



ORONITE CHEMICAL COMPANY

38 SANSOME ST., SAN FRANCISCO 4, CALIF.   STANDARD OIL BLDG., LOS ANGELES 15, CALIF.
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.   600 S. MICHIGAN AVENUE, CHICAGO 5, ILL.
MERCANTILE SECURITIES BLDG., DALLAS 1, TEXAS

2343

A 500-liter Dewar Flask, made of Monel®, used for transporting liquefied gases. Hofman Laboratories, Inc., of Newark, N. J., chose Monel for this service because it has the necessary strength and toughness at −330°F., and because Monel takes a mirror finish required for very high insulating vacuum.

What happens when temperatures DROP?

Many materials behave strangely at sub-zero temperatures . . . but Inco Nickel Alloys often have *improved* characteristics . . .

When the mercury freezes solid . . . and the temperature keeps on falling, common objects develop startling traits.

A rubber ball shatters under a hammer blow. An orange can be used to drive a nail. A garden hose becomes a rigid bar that will support your weight.

To the designer of low-temperature equipment, these unfamiliar antics pose serious problems. Many metals become excessively brittle . . . often to the point of being useless as structural materials. For example, an alloy steel, with a room temperature impact strength of 119.8 foot-pounds, showed a drop in impact strength to only 6.4 foot-pounds at the temperature of liquid nitrogen. Other carbon and low alloy steels show similar tendencies.

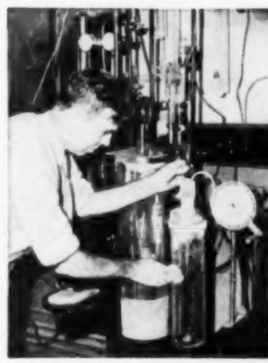
The key that has unlocked many such problems is *nickel*. Used as an alloying element in steels, nickel decreases low-temperature embrittlement.

The Inco Nickel Alloys, Monel, Nickel and Inconel, actually *increase* in strength when temperatures drop, and without appreciable change in ductility.

In addition to very superior low-temperature characteristics, the Inco Nickel Alloys offer several other important engineering advantages . . . excellent resistance to the corrosive action of a wide variety of chemicals, workability and weldability, good resistance to both stress- and vibration-fatigue.

Among the many low-temperature applications, where Inco Nickel Alloys can prove highly successful, are: producing, handling and storing of liquefied gases; laboratory research, low temperature treatment of metals.

Right now nickel and nickel alloys are on extended delivery because so much is needed for defense. Therefore, it's wise to anticipate your needs and place your orders, with necessary N. P. A. ratings, well in advance. And for helpful advice on metal problems, feel free to consult Inco's Technical Service Section. They will be glad to help you — without cost or obligation, of course.



Helium liquefier at the National Bureau of Standards, used to study the behavior of the gas at −455.75°F. — less than 4 degrees above absolute zero. Heart of the apparatus is a thick-walled Monel chamber in which helium is cooled under pressure, preparatory to expansion and liquefaction.

EMBLEM OF SERVICE

NICKEL INCO ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL

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NICKEL • LOW CARBON NICKEL
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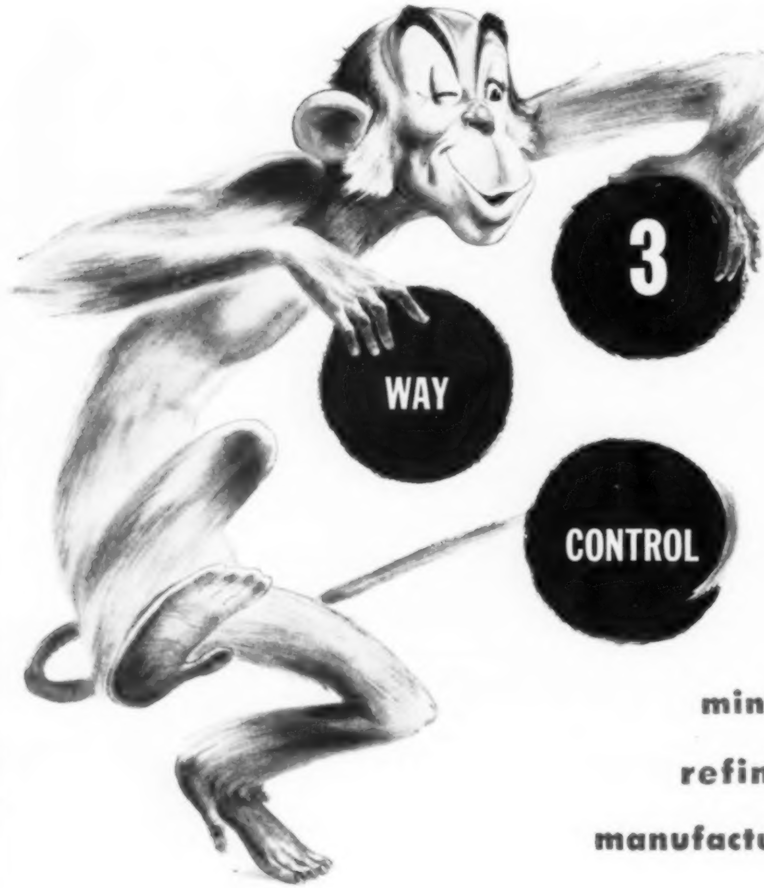
NIMONICS

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.



mining

refining

manufacturing

INTERNATIONAL POTASH CHEMICALS

When you depend on *International* as your source of supply for potash chemicals, you can be sure of the materials you want, when you want them. You get on-time deliveries of the quantities you need because of *International's* exclusive three-way control of the production of potash chemicals . . . mining, refining, manufacturing.

International's large mining and refining facilities at Carlsbad, New Mexico, provide ample supplies of raw materials. The electrochemical manufacturing plant at Niagara Falls, New York, assures you fine quality chemicals that accurately fit your specifications.

Address inquiries to Industrial Potash Department, International Minerals & Chemical Corporation, 20 North Wacker Drive, Chicago 6; 61 Broadway, New York 6.

potash chemicals Caustic Potash—All Standard Grades • Carbonate of Potash—All Standard Grades • Potassium Chloride—Refined and Technical Grades • Potassium Sulfate • Chlorine

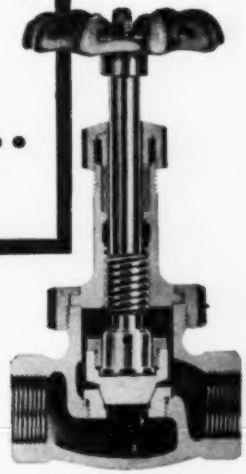
International Minerals Chemicals

potash division

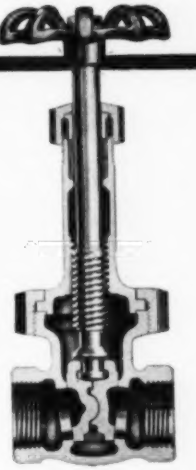
INTERNATIONAL MINERALS & CHEMICAL CORPORATION

General Offices: 20 North Wacker Drive, Chicago 6

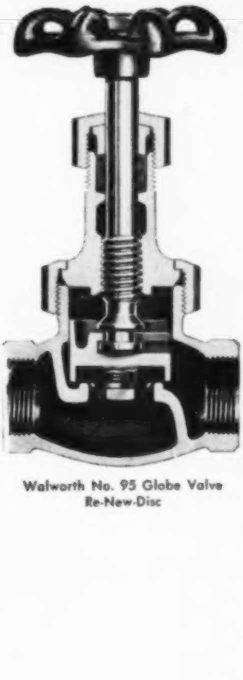
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc



Walworth
No. 29 Gate Valve



Walworth No. 95 Globe Valve
Re-New-Disc

built to give dependable trouble-free service on <u>all</u> recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:

GLOBE

GATE

ANGLE

WALWORTH

valves and fittings

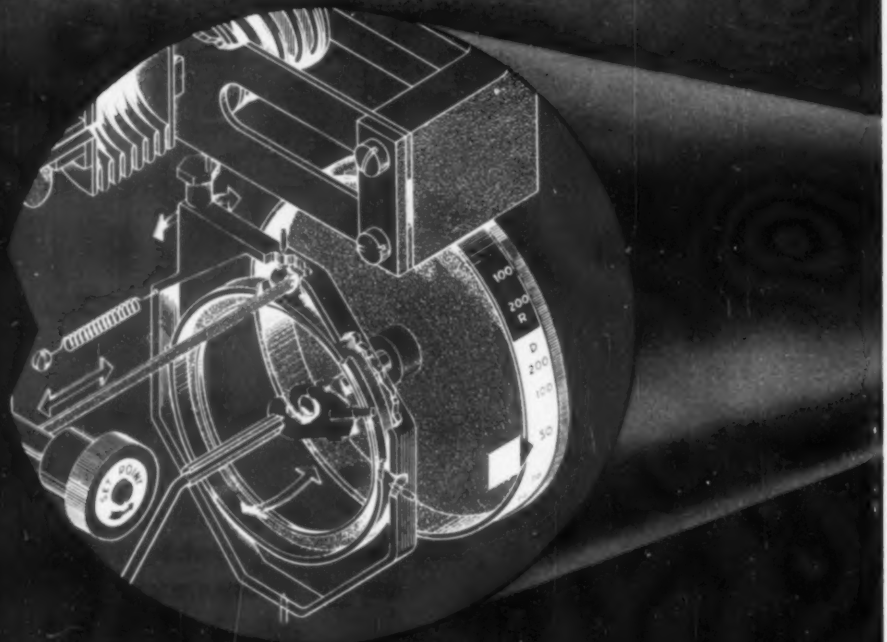
60 EAST 42nd STREET NEW YORK 17, N. Y.

CHECK

HERE IS A *Completely*

... with a Mechanism You've Never Seen Before

THE
GIMBAL
UNIT



Exclusive Advantages!

ONE control mechanism gives you **FOUR** combinations of primary and feedback motion to obtain Direct Proportional, Reverse Proportional, Direct Differential-gap and Reverse-Differential-gap Control.

With **ONE SETTING** you select type of control, type of action and proportional band or differential-gap setting.

A HIGH CQ PRODUCT

Concord #20 Steam Hose

BWH Concord #20 Steam Hose has a protective built-in lining of stainless steel wire braid that guards against tube swelling . . . assures dependable, long-lived service.

This rugged, braided inner lining assures maximum steam flow . . . permits easy recoupling in the field.

Other Concord #20 construction features: two or three braids of alternate high tensile steel wire and rubber layers firmly bonded over outside of tube. These provide maximum burst-protection and safety. An asbestos braid provides positive cover adhesion and acts as cover insulator. A durable, abrasion-resistant cover withstands severest abuse.

Put Concord #20 Steam Hose to work for *you — now!*

Illustration shows how special built-in lining of stainless steel inner wire braid assures long life under the most severe operating conditions.
Pat. applied for

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

BWH DEPENDABLE RUGGEDNESS

Distributors in all Principal Cities

PLANT: CAMBRIDGE, MASS. • P. O. BOX 1071, BOSTON 3, MASS., U. S. A.

Advantage of Independent Inventors?

If you have an idea for a new petroleum product—but do not have the facilities needed to develop it—the Sinclair Plan offers you laboratory help.

EIGHT months ago, Sinclair opened up a part of its great research laboratories to independent inventors who had ideas for new or improved petroleum products but who did not have the facilities needed to develop and profit by their ideas.

To date nearly 5,000 inventive people have submitted ideas to the laboratories; and the Sinclair Plan has become recognized as a service to inventors, the oil industry and the public. As a result we have made the Plan part and parcel of the long-range operation of our company.

If you have an idea for a new or improved petroleum product or application, you are invited to submit it to the Sinclair Research Laboratories. In your own interest, each idea must first be protected by a patent application or a patent.

If the laboratories select your idea for development, they will make a very simple arrangement with you: In return for the laboratories' work, Sinclair will receive the privilege of using the idea for its own companies, free from royalties. This in no way hinders the inventor from selling his idea to any of the hundreds of other oil companies for whatever he can get. Sinclair has no control over the inventor's sale of his idea to others, and has no participation in any of the inventor's profits through such dealings.

HOW TO PARTICIPATE: Instructions are contained in an Inventor's Booklet. Write to W. M. Flowers, Executive Vice-President, Sinclair Research Laboratories, Inc., 600 Fifth Avenue, New York 20, N. Y.

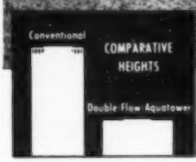
IMPORTANT: *Please do not send in any ideas until you have sent for and received the instructions.*

Nine buildings of the Sinclair Research Laboratories at Harvey, Ill.

SINCLAIR—for Progress

NEW DOUBLE-FLOW AQUATOWER

Marley Introduces Lowest Silhouette, Lowest Pumping Head Cooling Towers For Intermediate Capacities



New Simplicity • New Accessibility • New Efficiency

By combining the outstanding features of the large patented Double-Flow and the smaller Aquatower (both accepted leaders in their fields), Marley has produced the cooling tower that will set the standard in another size range . . . THE DOUBLE-FLOW AQUATOWER. Architects, engineers and contractors will be equally enthusiastic about this tower because it is highly efficient, lowest in height and harmonious with building design, and remarkably easy to erect.

The Double-Flow design means low tower height and low pumping head; efficient air utilization—one fan drawing air from two completely open sides—with consequent minimum fan horsepower requirement. Open distribution, "at-a-glance" inspection are features, as are minimum load concentration and economical grillage and support.

From the Aquatower comes simplicity . . . of construction, of piping, of operation. The nailless Redwood filling that is very easily installed or removed is another adaptation. All basin fixtures are readily at hand. Double-Flow Aquatower mechanical equipment is all designed, manufactured and guaranteed by Marley specifically for cooling tower usage . . . and it is all completely accessible.

You'll want complete details of this tower that will fit many installations in many industries, typical of which are those requiring 50 tons or more of refrigeration. Fill out the coupon below and you will receive it immediately.

Producers of
- DOUBLE-FLOW TOWERS
- AQUATOWERS
- VAIRFLO TOWERS
- CONVENTIONAL TOWERS
- DRICOOLERS
- NATURAL DRAFT TOWERS
- SPRAY NOZZLES

MARLEY

Protected by Marley Double-Flow patents

The Marley Company, Inc.

222 West Gregory, Kansas City 5, Mo.

Send me your 8-page brochure on the new Marley DOUBLE-FLOW AQUATOWER.

Name ______________________

Firm ______________________

Address ______________________

City ______________ State ______________

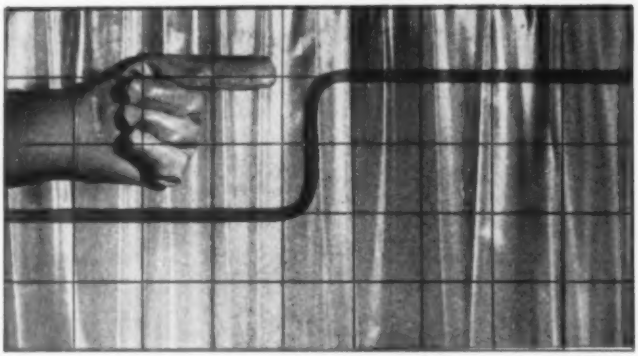
MONSANTO
CHEMICALS — PLASTICS

FOR YOUR INFORMATION

Every month Monsanto publishes these pages of pertinent information which may be helpful to you. This issue discusses:

- Plasticizers
- Hydraulic Fluid
- Polychlorobenzene
- Defoaming Agent
- Tetrasodium Pyrophosphate
- All-purpose Detergent
- Extender-type Plasticizer

Additional information on any of these subjects will be provided by any Monsanto Sales Office in response to your request by coupon or letter.



Step up vinyl production 33% to 100% without adding to your equipment

You can increase your output of extruded and calendered polyvinyl chloride products without adding new machinery. This forward step in efficiency is made possible by Monsanto's fast-fusion type plasticizers, Santicizer* 141, Santicizer 140 and Santicizer 160. Production increases generally are 33%, but, in some cases, they go up more than 100%.

This extra volume is yours without sacrificing quality. Often better quality results from the use of these Monsanto plasticizers. You may add such advantages as flame resistance, low toxicity, improved low-temperature flexibility and other characteristics to improve your sales.

With the proper selection of your plasticizer or plasticizer blend, you will gain one or more of these advantages:

1. The Banbury cycle on the average can be speeded up 33% (in some cases more than 100%), increasing production as much as ONE-THIRD.
2. The Banbury rotor speeds can be REDUCED, lowering power demand without increasing the time needed to process . . .
3. The processing temperature can be reduced, eliminating danger of discoloring without lengthening the time cycle.
4. The peak power demand can be lowered and the average horsepower over the processing cycle reduced.
5. Increased amounts of fillers, stabilizers and lubricants need not increase the processing time.

For information on these production-boosting, cost-cutting, quality-building plasticizers, contact the nearest Monsanto Sales Office or mail the coupon for a copy of Monsanto's new booklet "*Increased Capacity Through Faster Processing of Polyvinyl Chloride.*"

VALUABLE DATA FOR USERS OF HYDRAULIC FLUIDS

Just off the press is Monsanto's booklet, "*Pydraul F-9 . . . A report to engineering executives on a new nonflammable-type hydraulic fluid.*" The 12-page, file-size booklet gives valuable data for operators of die-casting machines, automatic riveters, automatic equipment, hydraulic presses and other equipment in which a nonflammable-type pressure transfer liquid is desirable.

The booklet gives specific details on the following characteristics of Pydraul* F-9: Fire resistance . . . high lubricity . . . noncorrosiveness . . . chemical stability . . . nonreactive qualities . . . pumpability . . . insolubility in water . . . nonvolatility. Pydraul F-9 contains no water or inorganic salts.

If you are interested in adding the extra safety of a nonflammable-type hydraulic fluid, plus the advantages of economy and efficiency, mail the coupon for a copy of the Pydraul F-9 booklet.

Research Chemists' Corner

You may find something new here

HERE'S A CHEMICAL WORTH INVESTIGATING

Properties of Monsanto Polychlorobenzene, Technical, indicate possibilities in a great variety of applications. Perhaps they suggest uses in your industry. Have a look at properties listed below. Then, if you are a qualified chemist and want to do some research, we'll be glad to supply you with samples. The coupon is for your convenience.

Typical Properties of Polychlorobenzene

Appearance	Dark brown liquid and solid
Crystallizing point	27.8°C.
Acidity (mg. NaOH/gram)	0.032
Specific Gravity at 100°/15.5°C.	1.494
Fractional Distillation (one sample)	
Dichlorobenzene	2.2%
Trichlorobenzene	22.8%
1,2,3,4-Tetrachlorobenzene	51.8%
1,2,4,5-Tetrachlorobenzene	5.8%
Residue (Pentachlorobenzene, Hexachlorobenzene and other high boiling residue)	17.4%
Crystallizing Point of tetra fraction	40.00°C.

Solubility of Polychlorobenzene in Oil

In Monsanto tests the material dissolved readily in regular lubricating oil, SAE No. 10, at 25°C. Five per cent increments of the sample (by weight) were added to the oil until a weight equal to that of the oil itself had been added. No separation occurred, indicating good solubility of the material in this oil.

Monsanto to build phenol plant on West Coast

Construction of a new Monsanto plant to produce phenol will get underway in mid-year on an 83-acre site at Avon, California.

The new unit, which will be in production in 1954, will supply phenol to contract customers of the growing West Coast industrial area. It also will supply the expanding needs of Monsanto's Pacific Coast manufacturing operations.

Monsanto's West Coast plants make phenolic resin adhesives and various other phenolic resins. Future plans call for the addition of a number of industrial and agricultural chemicals to the western production.

FOAMING CONTROLLED

Monsanto AE-1—a new high-molecular-weight alcohol ester—has definite defoaming applications. Also, other uses that yield economies in various processing operations.

some AE-1 applications

It is used as a defoamer in producing ethyl alcohol from molasses . . . defoamer in producing glycerol from fats . . . for foam control in the manufacture of yeast and other fermentations . . . control of foam in certain bottle-washing operations . . . solving foam problem in polystyrene latex water dispersions . . . lubricant for vinyls that are extruded or calendered . . . coplasticizer for rubber hydrochloride and chlorinated rubber.

This list of uses may suggest some interesting applications to you. If so, write for samples of AE-1 and Technical Bulletin No. P-140.

$$\frac{1+1}{2} = 1+$$

Higher detergency from synergistic action

There are numerous places where the higher detergency effected through synergistic action affords important economies in industry cleaning and scouring.

Synergism is achieved by blending Santomerse* No. 1 and Monsanto tetrasodium pyrophosphate with the result that their combined detergencies are higher than the average of the two when used separately; higher than the detergency of either. This effect is of particular consequence in many phases of textile processing.

Many uses for TSPP

Monsanto tetrasodium pyrophosphate is also widely used as a soap builder, household and industrial cleaner and detergent, in bleaching, in dye baths as an assistant for putting certain types of dye in solution, in metal cleaning . . . For full information, send for Technical Bulletin No. P-24.

HB-40 — low-cost extender-type PLASTICIZER

At an l. c. l. price of 17¢ per pound (less in carloads), the use of Monsanto's HB-40 as an extender-type plasticizer will enable you to save as much as 30% to 50% in processing vinyls. Not only does HB-40 help reduce your costs very materially — it also helps you maintain your product quality. Available now in drum and carload lots.

HB-40 is finding wide use in producing vinyl extrusions, vinyl pastes, vinyl slush moldings and vinyl calendering. It is also of special interest as a low-cost extender-type plasticizer in polystyrene casting resins, polystyrene adhesives, molding polyvinyl carbazole, strip coatings for metals, floor tile compositions, asphalt base paints.

Send for full information; ask for Bulletin No. P-104.

now available AROCLORS in ample supply

As a result of increased production capacity, the greater availability of Monsanto AROCLORS* is welcome news to processors in many different fields who have long depended on the unique properties of these chlorinated biphenyl—chlorinated phenyls.

The AROCLORS find prominent uses in the electrical insulating field and in such widely differing applications as nonflammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes.

The AROCLORS are very efficient and very economical, both when used alone to accomplish results not attainable with other materials and when used as extenders to enhance the properties of other products.

GET AROCLOR BULLETINS

There are numerous bulletins on the many applications of Monsanto AROCLORS—General . . . Chlorinated Rubber . . . Pliolite . . . Incombustible Lubricants in High-Pressure Compressors . . . Indirect Heater for Unit Control Operations . . . Co-Plasticizers for Polyvinylchloride . . . Co-Plasticizer with DOP for Vinyl Organosols and Pastes.

Investigate the AROCLORS! Please send for bulletins that interest you.

• • • • • • • •

MONSANTO CHEMICAL COMPANY, 1700 S. Second Street, St. Louis 4, Missouri. District Sales Offices: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle. In Canada, Monsanto Canada Limited, Montreal.

*Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS AND PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

SEND LITERATURE:
☐ Pydraul F-9. ☐ Faster processing of Polyvinyl Chloride. ☐ Tetrasodium Pyrophosphate. ☐ AE-1. ☐ HB-40. ☐ Santomerse No. 1. ☐ The AROCLORS for....................
....
(please state uses).
SEND SAMPLE:
☐ Polychlorobenzene. ☐ AE-1.

MONSANTO CHEMICAL COMPANY
1700 South Second Street, St. Louis 4, Missouri

Please send, without cost or obligation, literature or samples as indicated at left.

Name..Title..............

Company..

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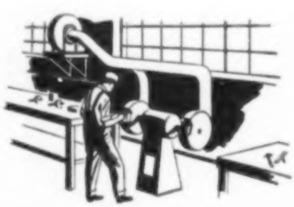
City..............................Zone........State...............

American Blower... a time-honored name in air handling

Charleston, W. Va., has a conveniently located American Blower Branch Office to provide you with data and equipment for air handling. You can reach American Blower in Charleston by calling 61-331. In other cities consult your phone book.

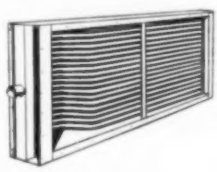
EMPLOYEE COMFORT

Fresh, invigorating air, indoors, does much to increase employee morale and efficiency. American Blower Ventura Fans are ideal for the job. They're attractively streamlined propeller fans with smooth-flowing lines that harmonize well with modern business interiors. Wiring is fully enclosed for safety. A square mounting panel makes them easy to install. All Ventura Fans are sound-rated and capacities are Certified.



ABRASIVE MATERIALS

If you've found dust from grinding machine operations hard to handle, American Blower Type V Fans are well worth investigating. The heavy cast-iron housing of Type V fans easily withstands the wear of hard, gritty, abrasive materials. Also, their volume and pressure range is more than adequate to handle the normal requirements of this type of work. Remember, good ventilation is good business.

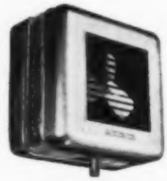


HEATING COILS

Current demands for heating from business and industry are greater now than ever before – a good reason to take early action on American Blower Heating Coils. Whether you need coils for use in blast heating or zone reheating – you'll find the size and type to fit your needs in the American Blower line. All tubing is helically wound with copper or aluminum fins in 3 standard spacings. Casings are heavy galvanized steel; headers are die-formed steel.

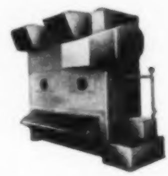
YOUR BUSINESS

Whatever your needs, American Blower heating, cooling, drying, air conditioning and air handling equipment will improve over-all comfort and efficiency in your business. For data, phone or write our nearest branch office.

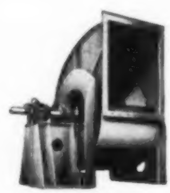


Unit Heaters

Ventura Fans



Air Conditioning Equipment



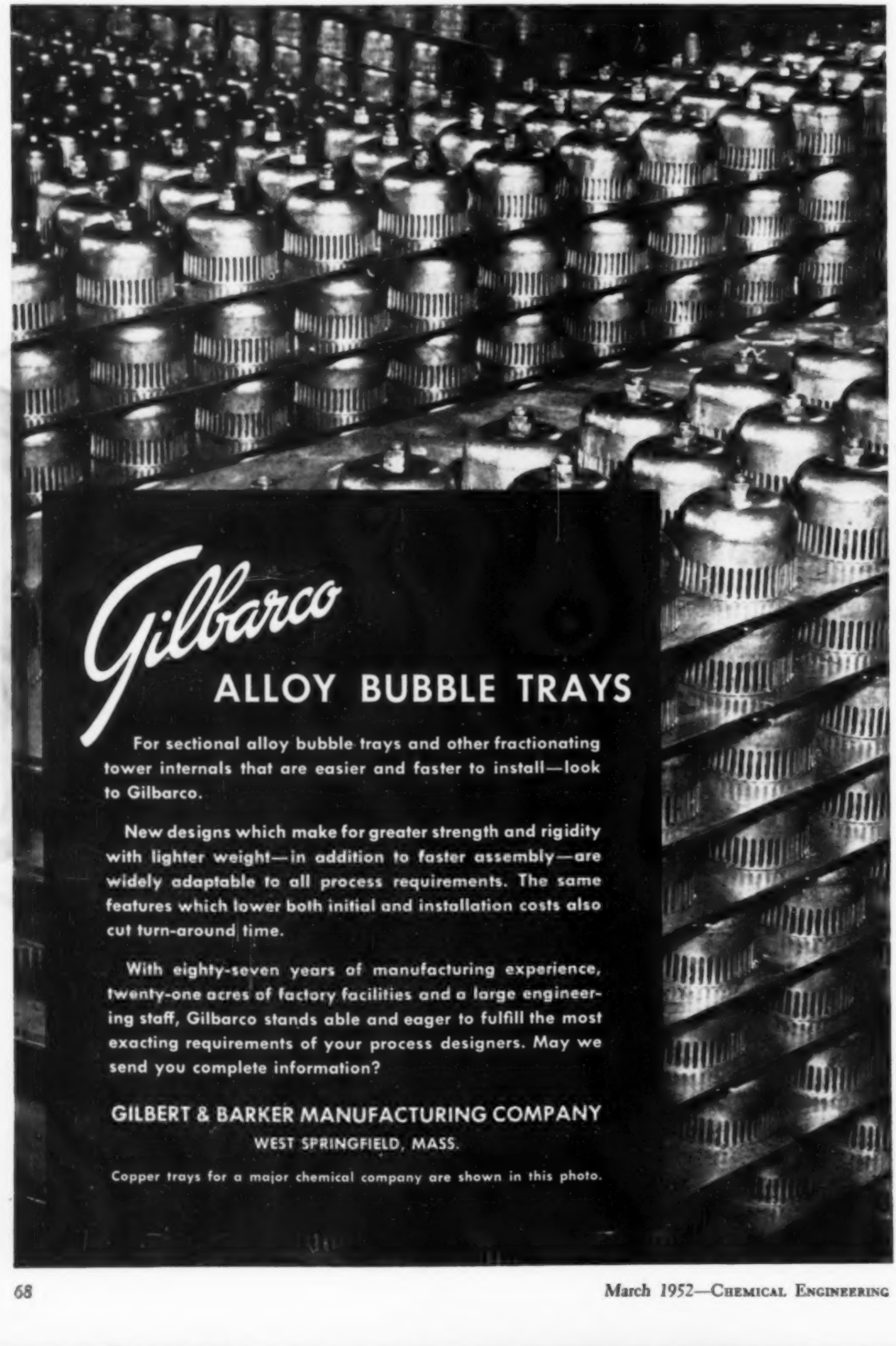
Industrial Fans

Utility Sets

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • ACME CABINETS • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON


Gilbarco
ALLOY BUBBLE TRAYS
For sectional alloy bubble trays and other fractionating tower internals that are easier and faster to install—look to Gilbarco.
New designs which make for greater strength and rigidity with lighter weight—in addition to faster assembly—are widely adaptable to all process requirements. The same features which lower both initial and installation costs also cut turn-around time.
With eighty-seven years of manufacturing experience, twenty-one acres of factory facilities and a large engineering staff, Gilbarco stands able and eager to fulfill the most exacting requirements of your process designers. May we send you complete information?
GILBERT & BARKER MANUFACTURING COMPANY
WEST SPRINGFIELD, MASS.
Copper trays for a major chemical company are shown in this photo.

REGARDLESS OF SIZE . . . they must
have Dimensional Accuracy
MIDWEST
PIPING & SUPPLY CO., Inc.
Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic, Los Angeles and Boston
Sales Offices: New York 7—30 Church St. • Chicago 3—79 West Monroe St.
Los Angeles 33—520 Anderson St. • Houston 2—1213 Capitol Ave.
Tulsa 3—224 Wright Bldg. • Boston 27—426 First St.
STOCKING DISTRIBUTORS IN PRINCIPAL CITIES
MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS
9743

FACTS

about

ETHYLENE

and

PROPYLENE OXIDE

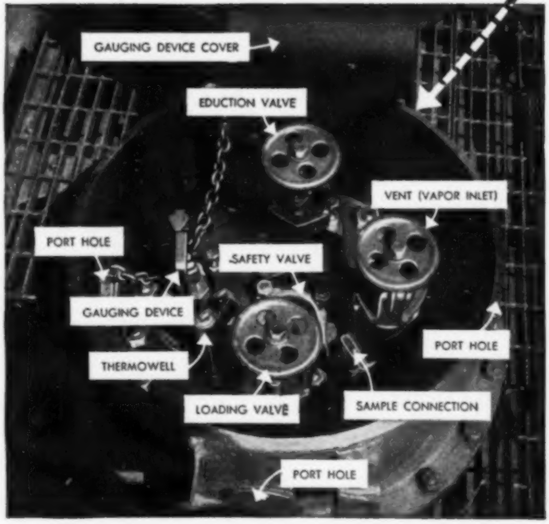
Today, more than ever, chemical materials should be used wisely and efficiently. The importance of Ethylene Oxide and Propylene Oxide to many industries has led Dow to believe that the following information may be of assistance in helping you realize greater value from these oxides.

Practically every major industry uses Ethylene Oxide or one of its many derivatives. Because Ethylene Oxide reacts with many other chemicals including fatty acids, phenols, alcohols and water, it is a basic component in many products. Ethylene Oxide is used in the manufacture of detergents . . . permanent antifreeze . . . cosmetics and bread conditioners. Propylene Oxide reacts with acids to form esters and with phenols to form phenoxy alcohols. In addition to the use of Propylene Oxide as an intermediate, it may be used as a low boiling solvent for cellulose acetate, nitrocellulose, vinyl resins, natural resins, hydrocarbons and as a sterilizing agent or product to inhibit the action of yeasts and molds.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

PROPERTIES

	Ethylene Oxide	Propylene Oxide
Molecular Weight	44.0	58.1
Boiling Point	51.3°F.	95.0°F.
Freezing Point	−168.2°F.	−169.6°F.
Flash Point (TAG Open Cup)	below −4.0°F.	below −21.0°F.
Fire Point (TAG Open Cup)	below −4.0°F.	below −21.0°F.
Specific Heat, Btu/(lb) (°F.)	0.44	0.47
Heat of Vaporization (1Atm), Btu/lb.	245.0	213.2
Density, g/cc	$0.896^{32°F}$	$0.827^{68°F}$
Refractive Index	$1.3614^{39.2°F}$	$1.363^{77°F}$
Explosive Limits (% Volume in Air)	2—100	2.1—21.5
Water Solubility, g/100g at 77°F.	∞	59
Alcohol Solubility	∞	∞
Ether Solubility	100	∞



Unloading Tank Cars of Ethylene Oxide or Propylene Oxide

1. The tank car should be accurately spotted on level track, the brakes applied, wheels blocked and appropriate caution signs displayed.
2. Attach approved ground connections to tank car before any contact is made with unloading equipment.
3. Attach inert gas line to vent valve of tank car and attach unloading line to eduction valve. Attach pressure gauge to loading valve. (These lines should be flexible steel with steel fittings. Wrenches and other tools used around Ethylene or Propylene Oxide should be made of nonsparking metals.)
4. Open loading valve to activate pressure gauge.
5. Open vent valve slowly and apply inert gas pressure to car to force Oxide into pump suction and to keep vapor phase of

This is one of a series of Dow advertisements you may wish to keep on file for reference and information. Write Dow for reprints.

Unloading Tank Cars (Cont'd)

tank car out of flammable range. A rotary pump is recommended for transfer of these materials.

6. When sufficient pressure has built up (about 35 psig) open eduction valve. This valve must be opened slowly so that excess flow check valve does not close.
7. Vent storage tank into which the Oxide is being pumped back into the tank car through the inert gas line. (The attachment of this vent line to the inert gas line must be made downstream from the compressor.)
8. When tank car has been unloaded, close valves and detach unloading lines. Care should be taken to allow no air to enter tank car. The car, containing principally inert gas, is then ready for return to Dow.

Handling Precautions:

Ethylene Oxide and Propylene Oxide are similar in many respects. Generally speaking, Ethylene Oxide is more reactive and more toxic than Propylene Oxide; however, the same general precautions should be applied to handling and working with both these chemicals.

Ethylene Oxide and Propylene Oxide are highly flammable and highly reactive. Every precaution should be taken in handling these materials to avoid any source of ignition. Explosion-proof motors and other electrical equipment including pumps, piping, storage tanks, and compressors should be well grounded.

No copper or copper-base alloys or any other acetylide forming metals should be used in contact with Ethylene Oxide or Propylene Oxide. All equipment used should be free of acids, bases, salts and water since most of these act as polycondensation catalysts. Oils, grease, dirt, air, sulfur, ammonia and hydrogen sulfide should also be excluded from contact with Ethylene Oxide and Propylene Oxide.

All new equipment or equipment which has been out of service should be thoroughly cleaned, dried and purged with an inert gas (i.e. Nitrogen or Methane) before being put into Ethylene Oxide or Propylene Oxide service. A blanket of inert gas should be kept on the Oxides to keep the vapor phase out of the flammable range.

Ordinary steel is acceptable for storage tanks and pipe lines. This equipment should be constructed to withstand an operating pressure of at least 50 psi. and should be insulated and provided with proper cooling equipment.

Toxicity:

Ethylene and Propylene Oxides should be considered hazardous chemicals in both their liquid and vapor forms. The prolonged single exposure to gas concentrations of but a few hundred parts per million can have adverse effects, and regular daily exposure to low concentrations should be avoided. The principal toxic effect resulting from inhalation is thought to be an irritation of the lungs which may produce, after several hours, inflammation and tissue destruction leading to pneumonia.

The following symptoms should be taken as evidence of excessive exposure: irritation of the eyes, nose and throat, headache, nausea, vomiting and weakness.

For emergency protection a full face gas mask with canister for organic vapors, or an air supplied respirator are suitable.

In the event of exposure, the casualty should be immediately removed from further exposure and placed under medical care. If liquid Ethylene Oxide or Propylene Oxide is spilled upon the person, all contaminated clothing should be removed at once and the affected area washed for several minutes with running water. Prolonged contact with the skin can cause severe blistering.

It is recommended that anyone who may be subject to exposure to Ethylene Oxide or Propylene Oxide be equipped with face shield, rubber gloves and other protective clothing.

WRITE DOW FOR INFORMATION AND TECHNICAL ASSISTANCE.

The Dow Chemical Company, Dept. OC-27, Midland, Michigan

- ☐ **Please send me additional information about Ethylene Oxide and Propylene Oxide.**
- ☐ **Please send ________ reprints of this advertisement.**

Name ____________________ Title ____________

Company ____________________________________

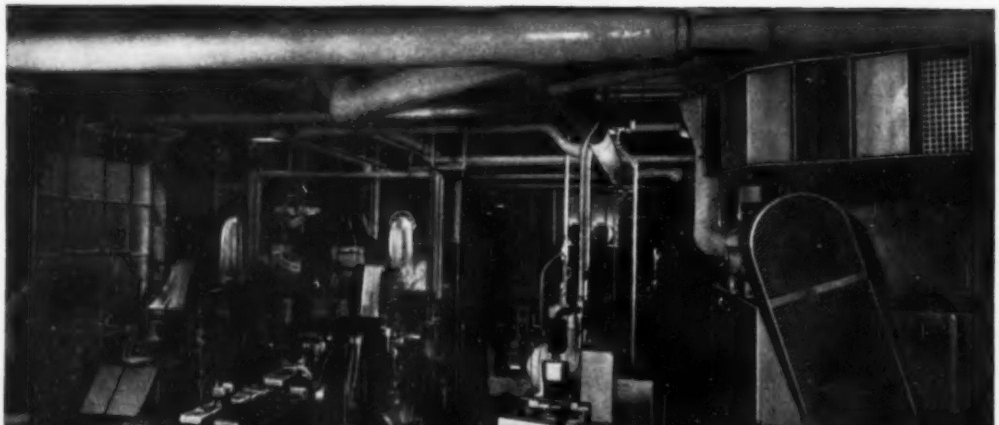
Address ____________________________________

City ____________________ State ____________

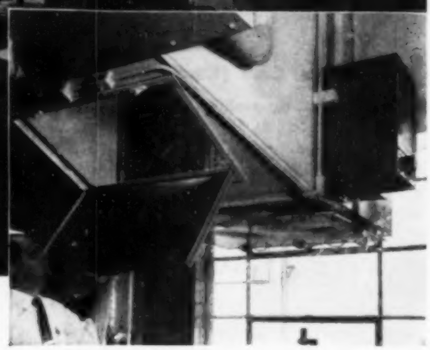
DOW

CHEMICALS

INDISPENSABLE TO INDUSTRY AND AGRICULTURE



Margarine processing and packaging rooms.



Electro-PL units installed overhead to save space.

where clean air is a must

AAF Electro-PL protects margarine processing from dust, smoke and bacteria.

Clean air is not a luxury, but a necessity for many food processes. This is particularly true of the margarine packaging operations. Here the margarine is exposed to the air, as it is formed for packaging, and is highly susceptible to contamination.

Electro-PL, AAF's dry type electronic air filter, now protects this critical stage for a nationally known food manufacturer in several margarine plants. Its high efficiency in supplying required clean air volumes that were free of dust and bacteria was originally proved in a test installation, then expanded to other plants. The original installation has now been operating successfully for two years.

In the Electro-PL the application of an electrostatic charge to a dielectric filtering material is an exclusive development of AAF research. It combines the advantages of both electronic and mechanical air filtration in a single compact, light-weight unit of exceptionally high efficiency. Equally important are the design factors of Electro-PL, which simplify installation and maintenance. Also, there is a weight saving of approximately 40% over electronic unit precipitators having metal plate collectors.

If you deal with processes "Where Clean Air Is A Must", call your nearby AAF representative, or write to us for full details on Electro-PL—Engineering Bulletin No. 257.

American Air Filter
COMPANY, INC.
326 Central Avenue, Louisville 8, Ky.
American Air Filter of Canada, Ltd., Montreal, P. Q. • Pacific Division Office, San Francisco, California

Build Fast at Low Cost with BUTLER BUILDINGS

Chemical plant at Memphis, Tenn., uses 50′ x 100′ x 14′ Butler Building with modified center section.

This Butler Building is one of 12 used by chemical company at Military, Kans. Installation provides warehousing for 15,000 tons of sacked ammonium nitrate fertilizer.

Adaptable to the Needs of All Chemical Plants

Yes, you can build fast and at low cost with Butler Buildings. All over the country chemical processing plants are using Butler Buildings for new construction or expansion . . . for processing, packaging or storage facilities.

Butler Buildings give you these advantages:

1. Low cost . . . save up to 50% of the cost of conventional construction;
2. Erected in days instead of weeks;
3. Adaptable to your special needs;
4. Fire-safe, weathertight, wind resistant;
5. Low maintenance;
6. Long-life construction;
7. Wide range of sizes;
8. Easily insulated, and at low cost;
9. Proved in use for more than 40 years.

Straight Sidewalls . . . Use all the space you pay for.

BUTLER

BUTLER MANUFACTURING COMPANY

Kansas City, Mo.
Galesburg, Ill.
Richmond, Calif.
Birmingham, Ala.
Minneapolis, Minn.

For prompt reply, address Dept. CE23 at office nearest you:
7338 E. 13th St., Kansas City 3E, Mo.
938 6th Ave., S.E., Minneapolis 14, Minn.
Richmond, Calif.

Send full information about Butler Buildings for use as ______________________

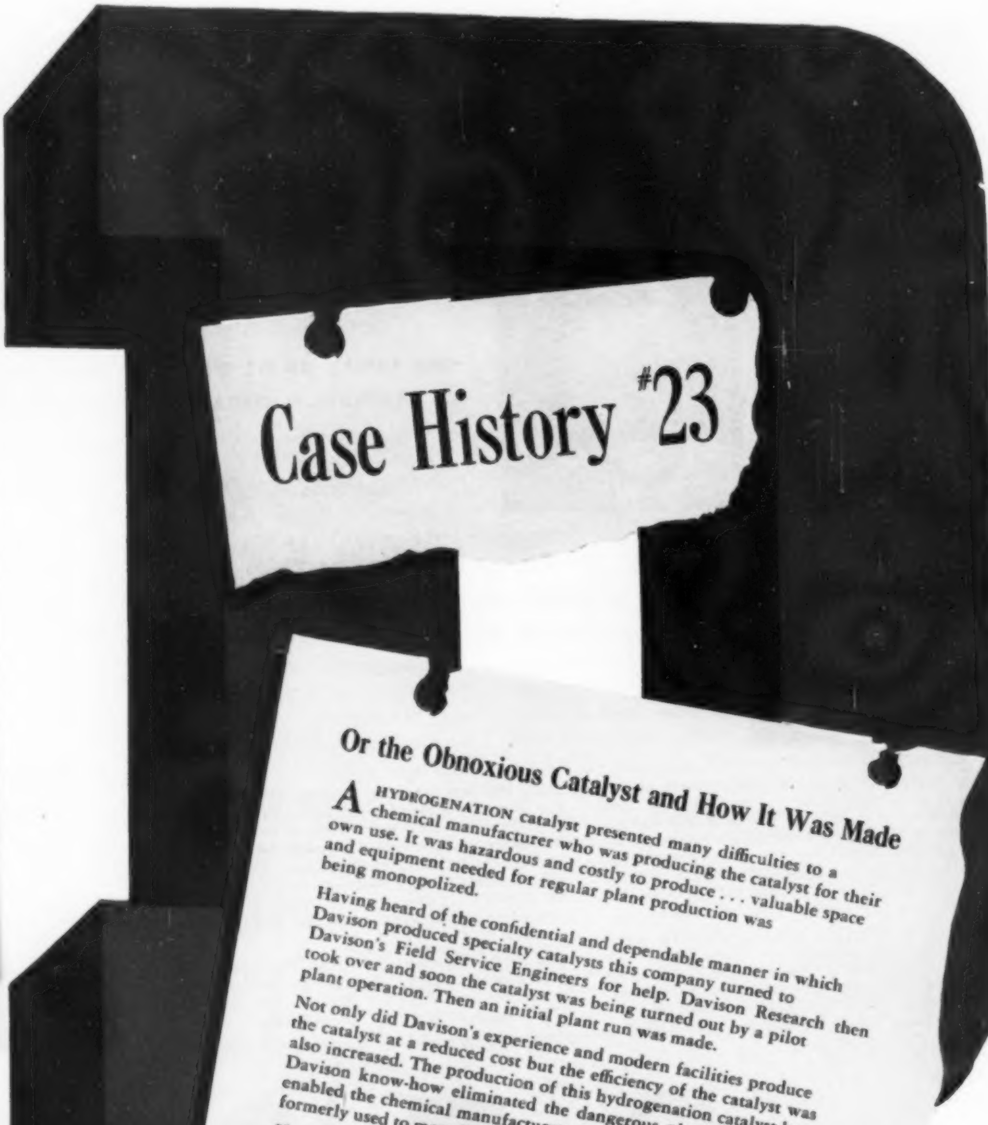
Send name of my nearest Butler dealer.

Name ______________________

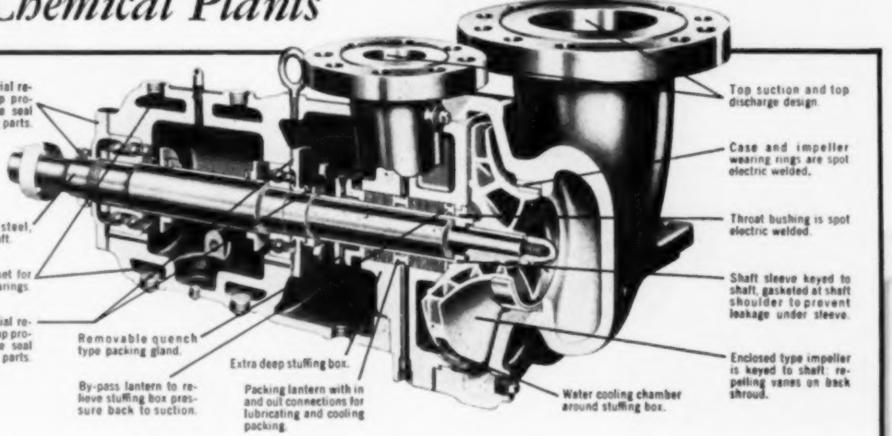
Firm ______________________

Address ______________________

City ______________ Zone ____ State ______________


Case History #23
Or the Obnoxious Catalyst and How It Was Made
A HYDROGENATION catalyst presented many difficulties to a chemical manufacturer who was producing the catalyst for their own use. It was hazardous and costly to produce . . . valuable space and equipment needed for regular plant production was being monopolized.
Having heard of the confidential and dependable manner in which Davison produced specialty catalysts this company turned to Davison's Field Service Engineers for help. Davison Research then took over and soon the catalyst was being turned out by a pilot plant operation. Then an initial plant run was made.
Not only did Davison's experience and modern facilities produce the catalyst at a reduced cost but the efficiency of the catalyst was also increased. The production of this hydrogenation catalyst by Davison know-how eliminated the dangerous plant problem and enabled the chemical manufacturer to utilize valuable space formerly used to manufacture the catalyst.
If you have a catalyst problem, why don't you contact the Davison Field Service Engineer or the Technical Service Department and put Davison Research to work for you.
Progress through Chemistry
THE DAVISON CHEMICAL CORPORATION
Baltimore 3, Maryland
PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

The **PEERLESS IDEA** *of the Modern Heavy Duty Process Pump for Refineries and Chemical Plants*

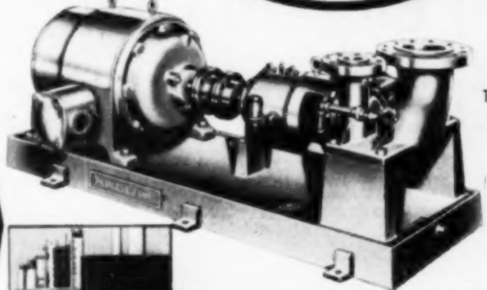


Peerless Type PR

PEERLESS PUMPS

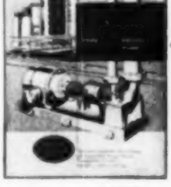
ESPECIALLY DESIGNED FOR PUMPING HYDROCARBONS, WATER AND CHEMICAL SOLUTIONS AT ELEVATED TEMPERATURES AND PRESSURES

The sectional view above shows many of the important Type PR pump design and construction features. Other Type PR advantages include maximum parts interchangeability, rugged center-line-mount, extra-low NPSH requirements, optional use of mechanical shaft seal instead of stuffing box, availability in various alloy materials and a complete range of sizes. Some sizes can be furnished from stock in standard materials.



Exterior view Type PR pump. Also available in end-suction top-discharge design.

WRITE FOR NEW BULLETIN
giving complete construction details, operating characteristics and application data. Mail coupon at right today.



PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26
Los Angeles 31, California

Please send us copy of Peerless Type PR Pump Bulletin No. B-1605.

NAME ____________________

COMPANY ____________________

STREET ____________________

CITY ____________________ STATE ____________

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Address inquiries to Factories at:
Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York, Chicago, St. Louis, Atlanta; Dallas, Plainview and Lubbock, Texas; Fresno, Los Angeles; Phoenix; Albuquerque, N. M.; Tulsa

PEERLESS BUILDS
Dependable **PUMPS**

A PHOTO-REPORT ON MODERN

New pumpless rectifiers in ratings of 750 kw and above, made possible by G-E semi-permanently sealed tanks, minimize vacuum losses, provide high service reliability. Maintenance is reduced because vacuum pumps are eliminated, and moving parts are at a minimum.

Outside the building at Oldbury's Niagara Falls plant and throat-connected to the rectifier equipment inside, is this G-E 12,000-volt step-down transformer. Induction voltage regulator at left, with taps for load ratio control, provides smooth, stepless voltage adjustment from 300 to 375 volts.

First pumpless rectifier in electro-chemical industry cuts d-c power-supply costs!

New G-E power-conversion package in larger ratings eliminates vacuum-pumping equipment, saves on installation, operation and maintenance

Latest example of G-E pioneering in power rectification is this recent installation—at Oldbury Electro-Chemical Company's Niagara Falls plant—of the electro-chemical industry's first pumpless mercury-arc rectifier. This new development, by eliminating vacuum pumping and combining the entire rectifier assembly in one compact, integrated unit, introduces savings like these:

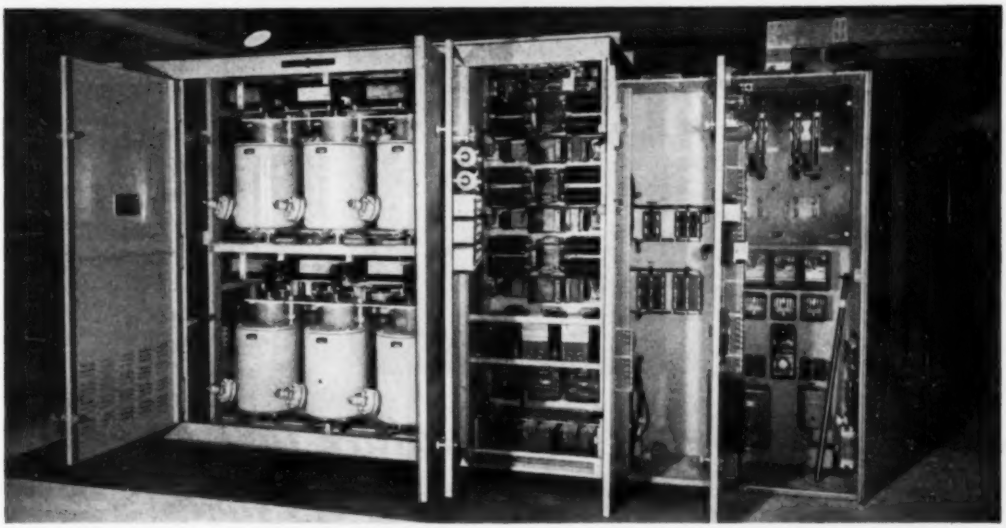
Cuts installation costs—Unit is factory-wired for quick connection, needs no special foundations, and takes up less building space. *Cuts operating costs*—No vacuum pumping losses are sustained. *Cuts maintenance costs*—With a minimum of moving parts, periodic inspections are reduced. Moreover, service reliability is increased—employees are protected by the dead-front metal enclosure—and downtime is reduced because of the speed with which a spare tank can be installed if needed.

If *your* chemical-plant operation requires reliable, low-cost d-c power supply, investigate these new G-E pumpless rectifiers. Ask your G-E representative for more information, or send for new Bulletin GEA-5569. *General Electric Company, Schenectady 5, N. Y.*

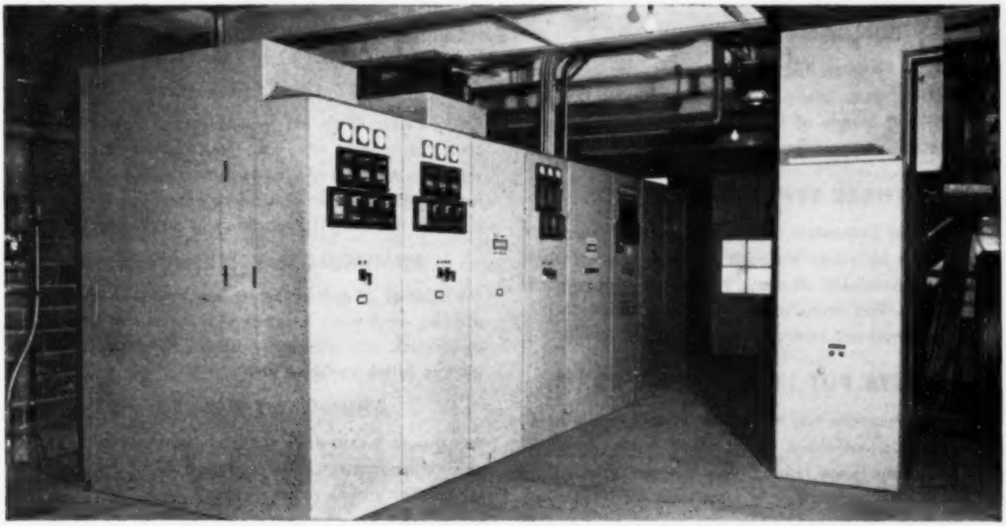
D-C POWER SYSTEMS

for electro-chemical plants

NEW G-E MOTOR SELECTION AND APPLICATION COURSE can help train your chemical plant electrical personnel, increase their value to you. Find out all about this "More Power to America" program by sending for free 16-page illustrated brochure, Bulletin GED-1500.



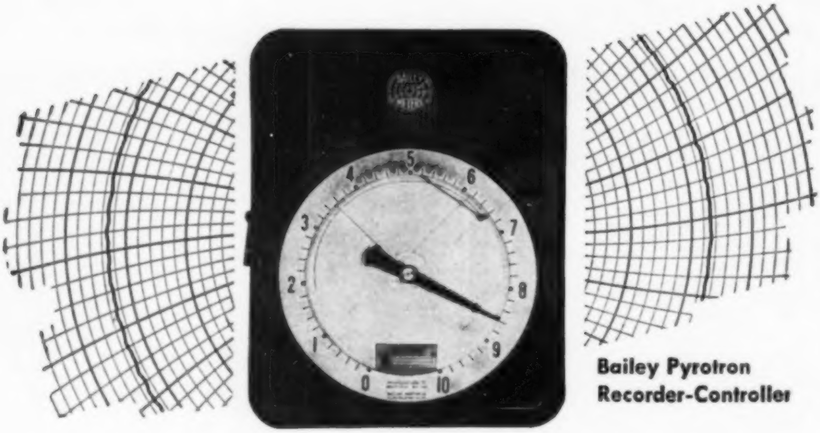
Compact and co-ordinated, G-E pumpless rectifiers fit in smaller buildings, save up to 25 per cent in building costs. Metal-enclosed assembly includes rectifier tanks, excitation cubicle, and rectifier auxiliary control. Factory-wired, they arrive ready to connect and operate.



Completing the package at Oldbury—to provide everything needed from incoming a-c line terminals to d-c outgoing feeders—is this G-E, 500-mva metal-clad switchgear, located in the basement. It includes one feeder and an auxiliary compartment for the rectifier. Unit at right is the draw-out cathode breaker section for protection of rectifier. Metal-enclosed for personnel protection, it pulls out easily to provide ample room for inspection.

GENERAL ELECTRIC

662-38



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

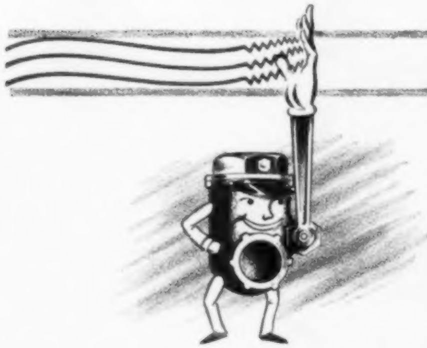
1054 IVANHOE ROAD • • • CLEVELAND 10, OHIO

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION

FLOW
LEVEL
DENSITY
RATIO

Specify this Fast-action Gate for quick, sure STOP and GO services

JENKINS



BRONZE GATE VALVE

125 lbs. Steam
200 lbs. O.W.G.
½" to 2"

Wherever full, free flow is essential . . . where valve opening and closing must be instantaneous . . . Jenkins SWINGTITE Fast-Action Bronze Gate Valves are setting new standards of performance and endurance.

The exclusive rolling disc and guide track design in the new Jenkins SWINGTITE distributes the wear, assuring maximum tightness (since it prevents uneven wear of seating surfaces), and lengthens valve life.

Use the SWINGTITE wherever fast-action valves take a beating on your processing lines. Compare it for long life and low maintenance. Prove for yourself that day after day it opens freely for full flow, and, closed, it seats tight and *stays* tight.

Ask your Jenkins Distributor for the folder, Form No. 196, describing the SWINGTITE in detail. Or write: Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros., Ltd., Montreal.

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS

SETTING NEW RECORDS FOR LONG LIFE AND LOW MAINTENANCE IN

- Oil refineries
- Textile finishing plants
- Chemical and food plants
- Pulp and paper mills
- Mines and mineral refining

AND IN SUCH APPARATUS AS

- Laundry machinery
- Dish-washing equipment
- Gasoline and fuel oil lines on motors, burners, etc.
- Fire extinguishing steam lines

ONLY THE SWINGTITE HAS IT—

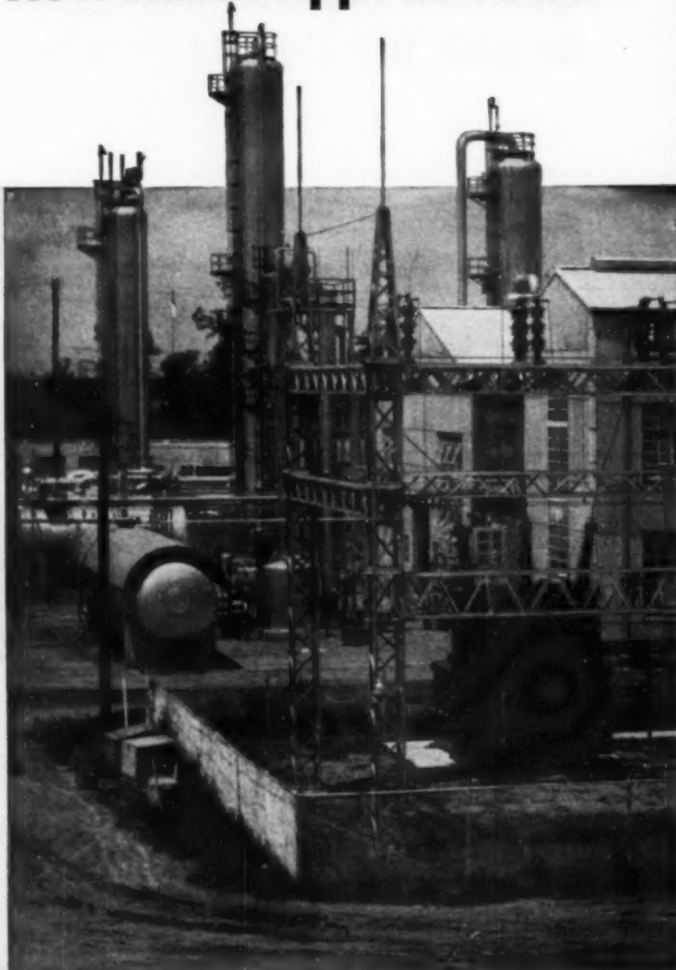
ROLLER ACTION

As the valve is opened or closed, guide rims (A) around the seating surfaces of discs roll freely over guide tracks (B) cast in the body, distributing wear evenly, dislodging foreign matter, and providing a polishing action for seating surfaces. This rolling disc and track construction lengthens valve life and assures maximum tightness.

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

How Mississippi Chemical



They did

Mississippi Chemical had a series of *over-all* electrical problems when they were planning this plant.

what

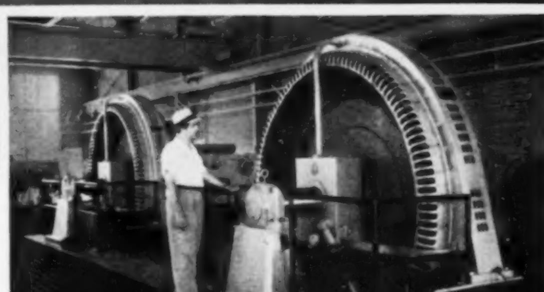
They had Girdler and Westinghouse Engineers *attack these problems as a whole.* Based on previous experience they put together a *co-ordinated electrical system.*

you can do

This experience and this over-all method can be applied to your next project, whatever it is. Westinghouse can work with you on *all* your electrical needs.

to produce more

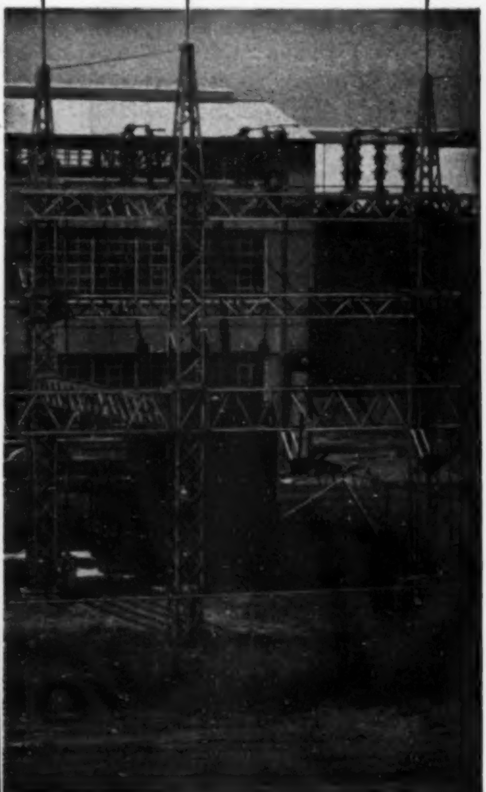
The result will be more dependable production . . . lower costs . . . better operations. Whether you need one motor, or a complex electrical system, call in Westinghouse.



Ammonia Superintendent inspects the 900-hp hyper compressor in the ammonia compressor room. Driving this compressor and all the other drives in the plant are Westinghouse Motors. These motors have a lower installed cost . . . are easier to operate . . . and require less maintenance than other types of drives.

got the BEST power equipment . . .

at no EXTRA cost !



Shown here is a Westinghouse Power and Control Center which supplies the power for the motors in the ammonia plant. These power and control centers are installed throughout the plant in nonhazardous locations to take advantage of grouped control.

Mississippi Chemical Company recently built a new plant in Yazoo City, Mississippi. For the electrical engineering, Westinghouse and the Girdler Corp., the engineers and prime contractors, put their heads together. By careful planning they developed a power system that uses the best type of modern equipment *but at no extra cost.* They made savings that offset the higher price. Here's how they did it.

Dependable, Low-Cost Power. To make use of the low-cost power available from the Mississippi Power and Light Company, a complete Westinghouse Substation was installed. Included were two 6000/7500-kva transformers. This rating permits line-starting of the large compressor motors and eliminates the need for costly special controls. The best secondary voltage was determined to be 2400/4160Y-volts. This reduces the size of the copper wire . . . keeps line losses at a minimum . . . and can be easily handled by standard transformers.

Top Motor Performance and Protection. For the main compressor drive, they chose electric motors because they have a lower installed cost . . . are easier to operate . . . and require less maintenance than other drives. The motor control centers were installed throughout the plant in nonhazardous locations. They got the advantage of grouped control without using more expensive, explosion-proof equipment.

Emergency Power Assured. For insurance purposes, an immediate source of stand-by power was required. Neither a combustion engine nor a condensing turbine met the requirements of fast, easy operation. However, a Westinghouse Type E turbine did the trick. It could be started by one man . . . reach full operation in 20 seconds . . . and it costs 25 percent less than any other adequate unit.

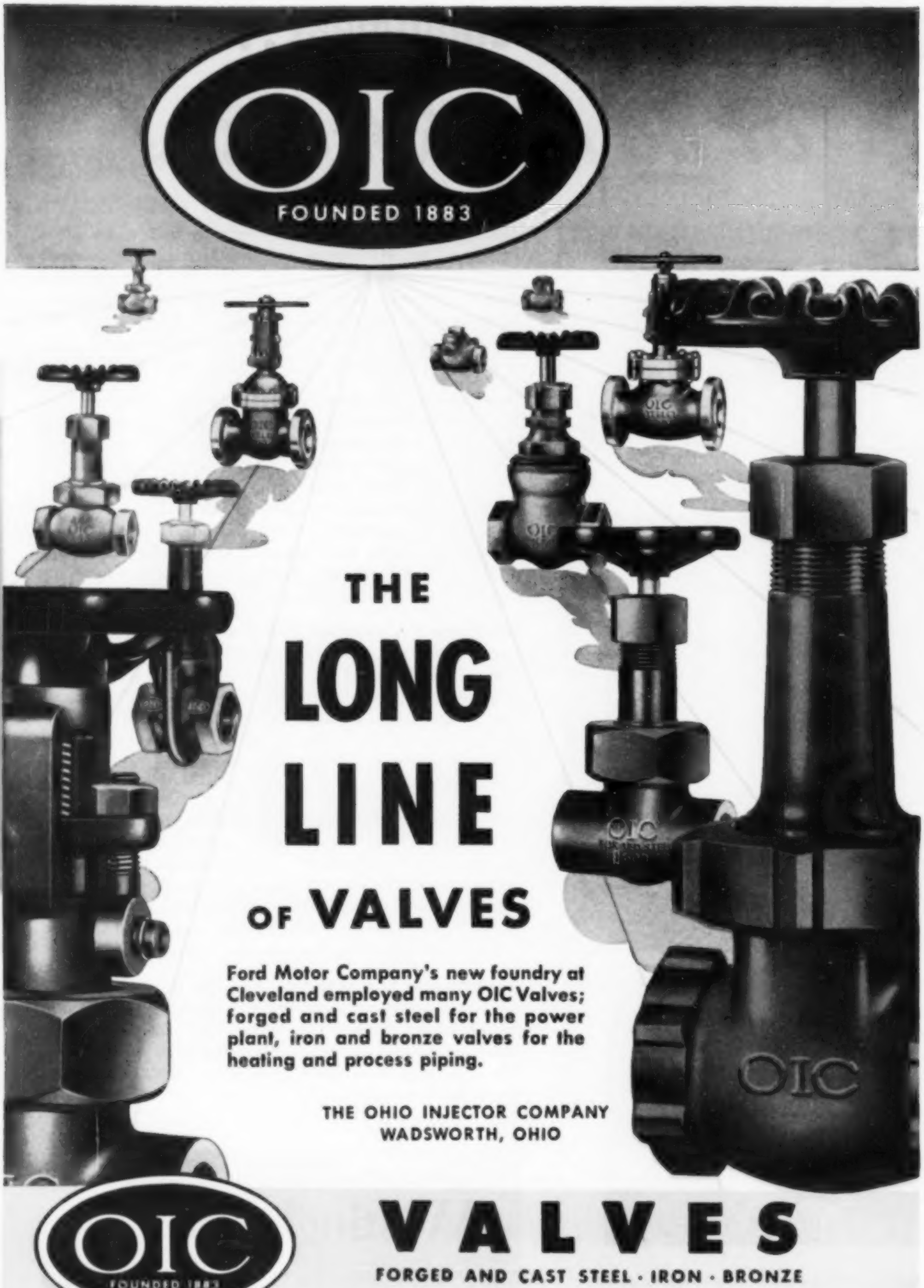
Westinghouse Can Help You. The next time you plan to build or expand your plant, call in Westinghouse. You can get these same benefits . . . the results of accurate system planning and dependable Westinghouse equipment. Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-94902

YOU CAN BE SURE...IF IT'S

Westinghouse

ELECTRICAL EQUIPMENT
FOR THE CHEMICAL INDUSTRY


OIC
FOUNDED 1883
THE LONG LINE OF VALVES
Ford Motor Company's new foundry at Cleveland employed many OIC Valves; forged and cast steel for the power plant, iron and bronze valves for the heating and process piping.
THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
OIC
FOUNDED 1883
VALVES
FORGED AND CAST STEEL · IRON · BRONZE

You Can Clean <u>This</u> Fluid Strainer <u>Without</u> Stopping the Flow

Cuno AUTO-KLEAN is the *only* fluid strainer with "comb-action cleaning" which permits it to work uninterruptedly. Dirt accumulations are dislodged *while* the straining goes on. This can be done automatically. *Guaranteed* to remove 100% of all solids larger than specified.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN

"Non-Stop" Fluid Cleaning Saves Time, Protects Quality

Many chemical plants have welcomed the Cuno AUTO-KLEAN strainer as a means of eliminating the problem of periodically cleaning or replacing a fluid cleaner.

The AUTO-KLEAN does not have to be dismounted or taken apart for cleaning, and it has no replaceable element. Hence, no need to shut down the equipment, no risk of exposing the product to contamination or the operator to harmful fluids or fumes.

The Cuno AUTO-KLEAN is continuously cleanable. The rotation of its all-metal discs against cleaner blades combs out accumulated solids which fall to the bottom for removal whenever convenient.

Never does process have to halt for sake of the strainer.

Many Metals Available

Cuno AUTO-KLEAN can be made in a wide range of materials to handle a wide range of fluids, viscosities, temperatures and solids. It is 100% permanent. The element is non-collapsible. It will last as long as the equipment on which it is installed.

Models are available for straining from .0035 to .062 in. Sizes to handle from a few to more than 4000 gpm.

Cuno Engineering Corporation
Dept. 103A, South Vine Street, Meriden, Conn.

Please send information on Cuno AUTO-KLEAN for ....
(process)

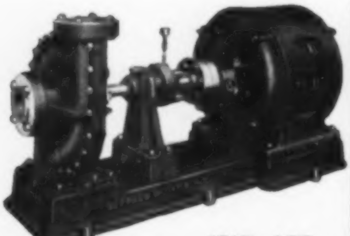
Name ....

Company ....

Address ....

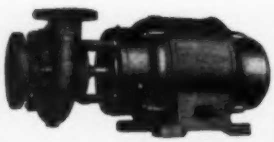
City ....Zone....State.....

Please attach to business letterhead



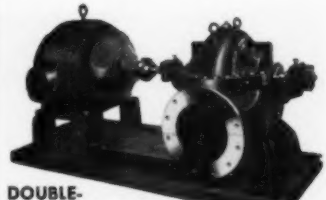
LEAD - ACID AND OTHER CHEMICAL PUMPS

"Buffalo" Chemical Pumps are available with lead lining like the pump shown, or rubber lined or of special alloys. Bulletin 982.



CLOSE-COUPLED PUMPS

A real space-saving design with no sacrifice in durability and efficiency. For clear water, but can be had in special alloys. Bulletin 975-B.



DOUBLE-SUCTION PUMPS

For top performance on clear water jobs, including air washers, these are of the finest materials and construction. Bulletin 955-N.

"Buffalo" PUMPS

MEAN MONEY SAVED THROUGH TROUBLE AVOIDED

True economy in pumping is in the pump you can install — and practically forget! "Buffalo" has always built such pumps. First cost may be a few dollars more than the "low-bidder" pump, but careful, sound "Buffalo" design and construction has always paid for itself in (1) longer years on the job, (2) fewer and shorter shutdowns, and (3) high efficiency.

As the pictures on this page show, you can pick a "Buffalo" Centrifugal Pump that's tailor-made for just about any liquid job you have. WRITE FOR BULLETINS!

BUFFALO PUMPS, INC.
501 BROADWAY BUFFALO, N. Y.
Canada Pumps, Ltd., Kitchener, Ont.

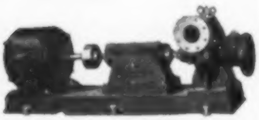
Branch Offices in all Principal Cities

— And For FANS . . .

. . . you'll find a full line of centrifugal, axial flow and propeller fans in the sizes and arrangements you want — a fan for every job! For best results on your next fan installation, look to "Buffalo". . . First For Fans. For complete information, write:

BUFFALO FORGE COMPANY
501 BROADWAY BUFFALO, N. Y.
Canadian Blower & Forge Co. Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities



PAPER STOCK PUMPS

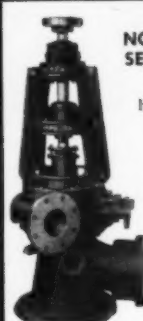
Diagonally-split-shell non-clogging pumps. A design for every liquid, every consistency, all proven in paper and pulp mills. Bulletin 953-F.

AUTOMATIC CONDENSATE PUMPS AND RECEIVERS

Will handle condensate at 212° F. without being affected in any way. Self-priming and trouble-proof. Bulletin 960-G.

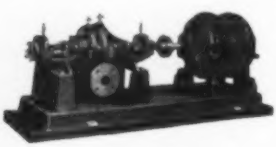
SUMP PUMPS

Self-contained vertical units ready to install. Rugged, trouble-free, with ball-bearing thrust and enclosed shaft. Bulletin 963-F.



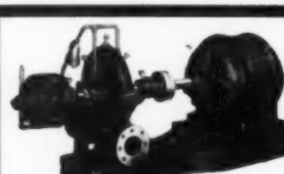
NON-CLOGGING SEWAGE PUMPS

Vertical and horizontal models for trouble-free operation in sludge circulation, agitation and removal, in lift stations and treatment plants. Bulletin 964-D.



TYPE "RR" PUMPS

For handling clear water, any temperature, at high pressures. Widely used for boiler feed. Rugged, efficient. Bulletin 980-B.



SELF-PRIMING PUMPS

Positive prime is maintained at all times. A popular feature available in all "Buffalo" Double Suction Pumps. Bulletin 970-A.

SPECIAL ALLOY PUMPS

Single suction, full ball bearing pumps, suitable for construction in most machineable alloys. Bulletin 982.

That's All the Cleaning an Allis-Chalmers TEFC Motor Ever Needs

MAINTENANCE COSTS ARE LOW for users of Allis-Chalmers Totally-Enclosed, Fan-Cooled Motors. They are easy to clean because even the stickiest dirt can be wiped or blown off without dismantling the motor or even stopping it. They seldom require cleaning because cooling air flows over the *outside* of the motor. There are no external concealed air passages to clog up and cause over-heating. You get better operational continuity, lower maintenance.

Bearings Save Maintenance, Too

Double-shielded ball bearings require no regular maintenance under most normal operating conditions. Yet if difficult service makes re-lubrication desirable, it can be done without dismantling the motor or bearings. Rigid cast iron frame and stiff end brackets maintain bearing alignment . . . assure maximum bearing life.

A-3639

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Your Allis-Chalmers Authorized Dealer or District Office can give you complete information on Allis-Chalmers Totally-Enclosed, Fan-Cooled Motors and how they can save you money. Call one of them today or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225.

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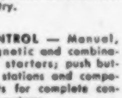
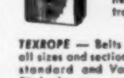
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.





PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

REPUBLIC
HOT MATERIAL conveyor belting

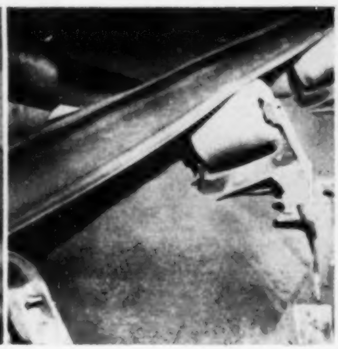
Put your hot cargoes on Republic Hot Material Conveyor Belts! That's the sure way to end costly breakdowns and maintenance bills resulting from high temperature exposure.

Republic Hot Material Conveyor Belts are made with special carcass fabrics imbedded in and covered with insulating rubber, specially compounded for resistance to heat, cutting and abrasion. Chances are there's a special Republic Hot Material Conveyor Belt already built for your specific job requirements. If not, 52 years of product development experience are at your service.

Your local Republic Distributor can help you decide whether you need duck, asbestos or glass ply construction. Contact him today or write today for full facts.

hot material handling without breakdowns!!

At the Carbon Limestone Company, Hillsville, Pennsylvania, pulverized limestone leaves a series of crushers, screens and heat dryers and drops stinging hot upon this Republic Rubber-Glass Belt. The work is continuous. But despite temperatures that exceed 300°F., up to 80 tons of material are handled during a single hour without harm to the belt.



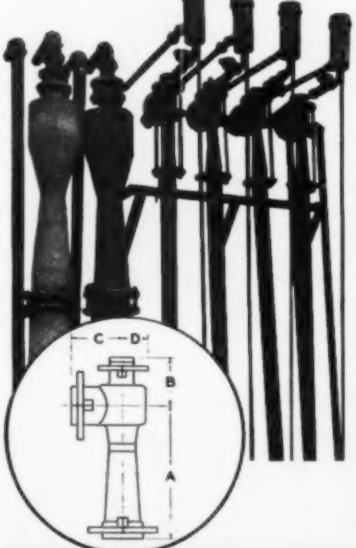
This Republic Rubber-Glass Conveyer Belt carries tons of smoldering sand for one of the world's biggest foundries. Temperature of the sand runs as high as 400°F. Mixed within the sand as it travels from shakeout racks to reclaiming stations are red-hot pieces of jagged metal. Despite the difficult work conditions, this Republic Rubber-Glass Conveyor Belt is giving ten times more service than the belt it replaced!

International Minerals & Chemical Corporation uses Republic Super Excelo Hot Material Belting to carry hot potassium salts through their Carlsbad, New Mexico, plant. The belt operates 20 hours per day. The load runs an average 325°F. temperature, yet the belt's performance record is considered to be "excellent."

Sure way to Beat the Heat!!

INDUSTRIAL RUBBER PRODUCTS BY
REPUBLIC RUBBER DIVISION
Lee Rubber & Tire Corporation
YOUNGSTOWN, OHIO

HAVEG



Connections					
Suction & Discharge	Water Inlet	A	B	C	D
4	1	18"	6 9/16"	6 1/2"	3 1/8"
6	2	31 1/2"	12 7/8"	11"	5"
8	2	41 3/8"	11 3/16"	10 3/8"	5 7/8"
10	2	46 3/4"	12 1/4"	12"	6 7/8"
12	2	54 1/4"	13 1/4"	13 1/2"	8 1/2"

OBNOXIOUS VAPOR SCRUBBER

• Haveg corrosion equipment is molded from a special plastic material into thousands of shapes and sizes. Large tanks and towers, pipes and valves, pump parts, all can and have been made from Haveg by the Haveg Corporation in its Marshallton, Delaware plant using an economical molding method. If you are building for the future you need to know all about this unique corrosion equipment. Since it is not a lining or coating and because it is a solid, molded non-metallic material *Haveg through and through* possesses uniform resistance to corrosion.

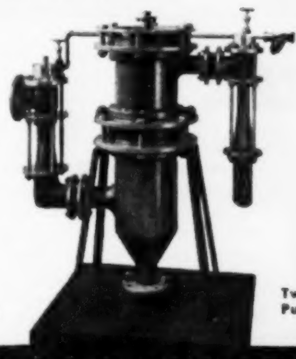
CUT COST... RESIST CORROSION

with HAVEG VAPOR CONDENSERS

• One example of the versatility of Haveg is its increasing use for high velocity jet apparatus when used in accordance with established chemical recommendations. The thermal properties of Haveg are such that it is unaffected by rapid temperature changes and will withstand operating temperatures up to 265°F (130°C) without damage.

Operating at low draft and actuated by water pressure, fume scrubbers or obnoxious vapor condensers made of Haveg have proven highly efficient. The throats or diffusers can be made of Haveg in any size and are resistant to wear resulting from high velocity liquids, resistant to the corrosive effects of many gases. Since Haveg can be machined, drilled, threaded, even repaired in the field, all assembly and maintenance is simplified. Also, because Haveg corrosive resistant equipment is molded, a wide range of sizes with individual modifications of the inner dimensions can be produced. Perhaps Haveg vapor condensers can replace for all time some other method you may be using to less advantage for the purging and absorbing of obnoxious gases. Jets, scrubbers, eductors, inter-condensers, all made of Haveg, may help you further cut costs, resist corrosion.

• A small part of the Haveg Story ... Vapor condensers may not be your problem of the moment, but Haveg should be your corrosion resistant material for the future. Write today for factual, 64-page Bulletin F-6 showing chemical resistance of Haveg, physical properties, design principles, machining, alterations and repair. This technical treatise is of lasting value if you must fight corrosion in your work. Write now! Or call your Haveg district sales engineer.



Two Stage S. K. Vacuum Pump with Intercondenser

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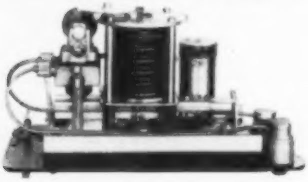
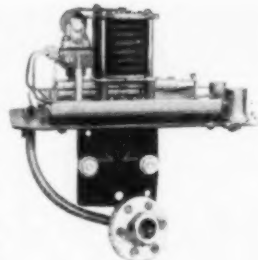
Mutual 1105

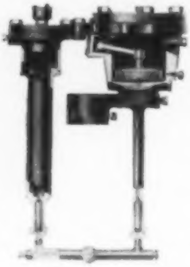
SEATTLE 7
5600 14th Ave. N.W.
Hemlock 1351

MEASURE

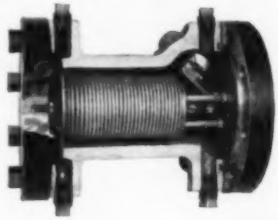


Taylor TRANSAIRE* Transmitters virtually eliminate time lag in measuring smallest changes in variables. Temperature model (*left*) has derivative action, SPEED-ACT*, in measuring circuit, which assures dynamic accuracy under changing conditions. Pressure model (*right*) detects changes of .1% of range span, accurate to ½% of range span rather than pressure level. Available in 20 and 40 lb. pressure spans to 400 lbs. limit, 50 and 100 lb. pressure spans to 1,000 lbs. limit. Temperature and barometric compensation.



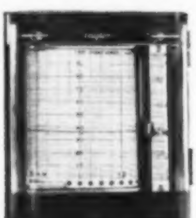


Taylor Differential Pressure Manometers give accurate, dependable measurement of flow, liquid level and specific gravity. Mercury model (*left*) is accurtae to ½ of 1% of the range, has interchangeable tubes for continuous ranges from 10 to 500 inches of water. Aneroid (mercury-less) models (*right*) of 300 and 1500 psi working pressures. Range limits: 0 to 20" to 0 to 500" water. Also available in all-316 stainless steel for corrosive mediums.



EVERYTHING'S

RECEIVE

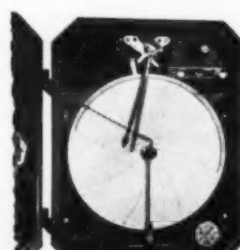


½% Accuracy of TRANSET* Recorder (*left*) takes fullest advantage of Transaire Transmitter precision. Recorder has automatic-manual unit, remote set-point adjustment, valve position indicator. Takes 4⅜" x 5" panel space. 30 day linear chart, 3 hours visible.

The TRANSET Indicator (*right*) has all the features of the TRANSET Recorder, but gives no chart record. Easy reading 3½" dial, mounts in same size panel opening as TRANSET Recorder.

TRANSET Receiving Flow Integrator (*left*) also takes just 4⅜" x 5" panel space. It totals the flow of liquids and gases, is available in square root or linear forms. Like the other TRANSET Receivers, its small size makes it ideal for graphic panels.

Taylor 84JF Recording Receiver (*right*) is an alternate part of the TRANSET System designed for those who want matching cases on conventional panel boards. Has all the features of the small TRANSET Recorder, but utilizes standard 12" circular charts.



THE *Chementator*

Reg. U. S. Pat. Off.

Prepared under the editorial direction of Joseph A. O'Connor, News Editor

Making benzoic by new method

Benzoic acid will be made by an entirely new synthesis from basic raw materials in facilities now being expanded by Monsanto at its St. Louis, Mo., plant. The unit will double Monsanto's production of benzoic.

New lithium process afoot

Foote Mineral Co. is now producing lithium compounds by a new process in its Exton, Pa., pilot plant, hopes to have a commercial plant substantially completed at Kings Mountain, N. C., in about a year. At capacity, the present ore treating plant at Kings Mountain, which Foote took over from Solvay, could turn out about 200 tons of alpha-spodumene, which will be the raw material for Foote's new process.

The new process uses no sulphuric acid, so there's no formation of intermediate lithium sulphate. Instead, products such as lithium carbonate, chloride, bromide and hydroxide are produced directly. And it should be easy to get the metal.

Foote is banking on its lithium hypochlorite bleach as a big outlet. It's competitive with perborate bleaches. Another growing market is in lithium greases. Ceramics and the welding industry also consume lithium compounds. And it cannot be forgotten that lithium metal is a source of tritium.

Another acrylic fiber enters field

American Cyanamid has at last taken the wraps off its new acrylic fiber X-51. Ease of dyeing and greater bulking power are outstanding advantages of the fiber, now in pilot-plant production at Stamford, Conn. Ease of dyeing is attributed to the process by which the copolymer is made. Acetate, acid (cuprous ion), basic, soluble vat and vat dyes can be used. As for bulking power, 3.0-denier X-51 is equivalent to 5.5-denier viscose staple.

From Carbide, more acrylic fiber

A 300 percent increase in output of its dynel acrylic fiber is planned by Union Carbide & Carbon Corp. A $30 million plant will be built at Spray, N. C., increasing capacity for the acrylic fiber from 6 million pounds to 26 million pounds a year. If Carbide gets a certificate of necessity from NPA, the new plant will be in production by 1954.

Units for production of raw materials to feed the new plant will be built at Institute, W. Va., and South Charleston, W. Va. This added dynel capacity will bring total acrylic staple output to more than 90 million pounds within two years.

Tougher target for hydrofluoric production

Production of hydrofluoric acid will be boosted to 130 million pounds a year by the beginning of 1955 as a result of the new expansion goal set by DPA.

The added capacity represents an increase of 36 million pounds over the capacity of 94 million pounds in January 1951. However, all but 9.7 million pounds of the increase is presently under construction or planned.

Big defense uses for hydrofluoric acid are in the manufacture of high-octane gasoline, pickling of stainless steel, refining of rare metals and production of Freons for use in refrigeration, air conditioning, plastics production and as propellants for aerosol bombs. Another important use that will grow is in the manufacture of the new fluorochemicals.

New way to make para-cresol

NOVEL PROCESS—More can now be revealed about how Hercules will make para-cresol and cymene alcohols in its new $8 million plant. When completed in 1953, the plant, to be built in New Jersey's Delaware River industrial area, will also produce phenol from cumene.

CYMENE OXIDATION—Para-cresol will be made by oxidizing para-cymene. The para-cymene will be made by dehydrogenating monocyclic terpenes.

Hercules, a primary producer of monocyclic terpenes and turpentine, which can be converted to monocyclic terpenes, is in a nice position to make pure para-cresol by the new oxidation process. Dehydrogenation of the monocyclic terpenes gives exclusively the para-cymene isomer. And this, in turn, gives pure para-cresol.

Present processes for making para-cresol give a mixture with the meta isomer. Purifying this mixture to get high-purity para-cresol is expensive. Use of the terpene raw material eliminates this high-cost operation and will make pure para-cresol more available.

MAKING CYMENE ALCOHOLS—Cymene alcohols will be made by hydrogenating mixed cymene hydroperoxides. These hydroperoxides will come from the

(*Continued*)

oxidation of synthetic cymenes. Mixed cymenes will be produced from toluene by alkylation. Similarly, in the process for making phenol, cumene will be made from benzene by alkylation.

HOW IT BEGAN—Hercules first got interested in the oxidation of hydrocarbons in the '30s when it sought to convert excess terpene hydrocarbons to oxygen-containing terpenes. Next it began to explore the little known organic hydroperoxides.

Soon Hercules discovered that the hydroperoxides of terpenes and of alkaryl hydrocarbons, as well as the alcohols derived from them, can be used as flotation agents. The corresponding alcohols are produced in high yield by catalytic hydrogenation or other reduction of the hydroperoxides. Hercules began limited production of these materials in a pilot plant at Brunswick, Ga., in 1947.

IMPETUS FROM SYNTHETIC RUBBER—Hydroperoxides were soon put to work catalyzing the polymerization of olefins. In 1945 Hercules introduced cumene hydroperoxide as a catalyst in emulsion polymerization systems. Shortly thereafter, its commercial use in synthetic rubber production began. In 1947 the rubber industry started to use cumene hydroperoxide in redox polymerization recipes for the cold rubber process. Other more active hydroperoxides, such as diisopropyl benzene hydroperoxide and para-menthane hydroperoxide, have likewise been put to work by the rubber industry.

What Allied will put its money on

Allied Chemical & Dye Corp. will spend \$75 million for expansion this year. This comes on top of an outlay of \$226 million since 1945, \$45 million of it in 1951 alone.

Allied now has 31 projects afoot, has been certified for \$80 million in fast tax writeoffs (60 percent of a \$130 million total expansion).

Customarily as cryptic as a wooden Indian in the past, Allied has now opened up enough to disclose that: (1) it will use its own process to make phenol from cumene; (2) it has done plenty of work on coal hydrogenation, enough to make it hesitate to go further right now; and (3) it is currently bearing down on plastics and synthetic fibers, especially polyamides, acrylics and polyesters.

Membrane sheets selectively permeable

A new process, using electric energy together with new synthetic membranes that are selectively permeable to ions, can be used to desalt sea water or brackish water, to purify chemical products and to recover valuable minerals and chemicals from process streams. The membranes, developed by Ionics, Inc., of Cambridge, Mass., are expected to find use in electrodialysis and dialysis.

Sea water can be desalted, using the new membranes, for as little as 10 to 20 c. per 1,000 gal. Power cost could be cut to as little as 6 c. per 1,000 gal., about one-third that required by the best present process. On brackish water, containing salt concentrations from one-tenth to one-fifteenth those of sea water, electrical energy consumed in purification would cost as little as 1 c. per 1,000 gal.

A stream of sea water fed to a unit using the membranes emerges after treatment, split into two streams —one a fresh water stream, two-thirds of the volume of the feed and containing practically none of the salt; the other a brine stream, one-third the volume of the feed and containing all of the salt. Before disposal, the brine can be further treated to produce salt, magnesium or other chemicals derived from sea water.

The process is continuous, with the electricity transferring the salt from the feed water. There's nothing cyclic about it, nor any regeneration. No chemicals are required. Electricity replaces regeneration. The membranes are long-lived because there's no cyclic process. A water stream can be introduced to carry off the ionizable material when a non-electrolyte carrier is used.

Advantages of the new synthetic membranes are: (1) selective transfer of ions of one sign only; (2) high electrolytic conductance; (3) high hydraulic resistance; and (4) mechanical strength. Ionics, Inc., can turn out the membranes in continuous sheets of the requisite mechanical strength for industrial use.

Basic structure of the membrane is a cross-linked maze of resinous polymer, not unlike a three-dimensional fish net. In the interstices of this structure there is water. An unbacked sheet of membrane may contain more than 50 percent water.

At different places in the network there are active charged spots bound into the structure. In an anion membrane these spots carry a positive charge; in a cation membrane, they are negative.

Each active spot is countered by an ion of the opposite sign that is more or less mobile and is dissolved in the water in the membrane. The more active spots per unit weight or volume, the higher the ion exchange capacity of the resin. Capacity of one typical unbacked membrane is 1.26 milliequivalents per cc.

If a membrane is placed in a solution of a salt containing the same positive ion as the membrane, ions are interchanged between the solution and the membrane. But the negative charges in a cation membrane, for example, cannot move. Accordingly, at all times, there will be a number of positive ions held in the structure equal to the number of the bound negative charges.

Some negative ions from the solution will also diffuse in, bringing with them an equal number of positive ions from the solution until Donnan equilib-

(Continued on page 106)

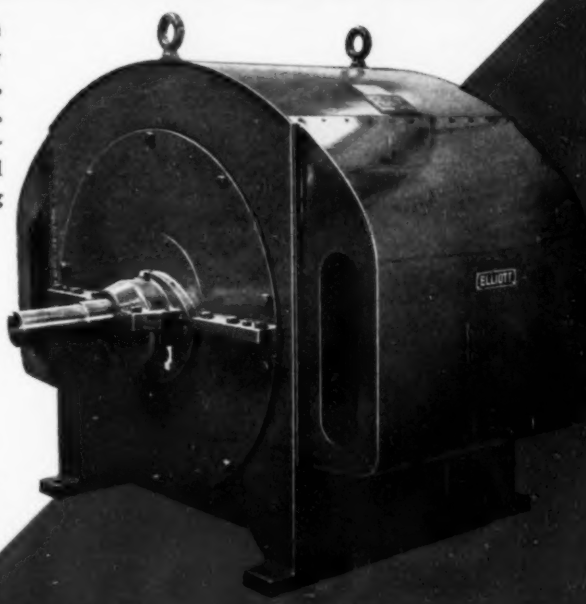
adaptability!

OTT

Fabri-steel motors

● Fabri-steel motors have established an entirely new set of standards in their easy applicability to individual conditions, some of them most difficult. For instance, the standard Elliott squirrel-cage induction motor, without change in electrical design, can be supplied with the following enclosures:

1. Outdoor splashproof
2. Vertical outdoor splashproof
3. Indoor splashproof
4. Frame modified for top discharge
5. Enclosed self-(base) ventilated
6. Totally enclosed, fan-cooled with top-mounted air-to-air heat exchanger
7. Totally enclosed, water-cooled with side-mounted air-to-water heat exchanger
8. Round frame for mounting inside a duct system with a forced-draft fan impeller mounted on tapered shaft extension.



Above is shown the Elliott splash-proof squirrel-cage induction motor, designed for outdoor service, and proven immune to the effects of rain, sleet, hail, fog, snow, sand, dust and temperature extremes. Over 200,000 hp of these motors are installed or on order, providing new economy in cost of housing eliminated, and new convenience in locating installations. They require no special foundation beyond a simple concrete slab. This motor is typical of Elliott advanced thinking in motor engineering.

Get complete data on this and other Elliott motors.

Company

DEPT. CE RIDGWAY DIVISION • RIDGWAY, PA.

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PRINCIPAL CITIES

rium is reached. When this happens there is always a smaller concentration of mobile negative ions in the membrane than in the solution, and a smaller concentration, in the membrane, of mobile negative ions than positive ions. In dilute solutions there are practically no mobile negative ions in the membrane.

Conductivity of the membrane is due to the high concentration of ions inside the membrane phase. These ions carry the current.

The new synthetic membranes are selectively permeable, exhibiting preferential transfer for ions of a given sign. A cation membrane shows high selective permeability for cations, an anion membrane for anions. In addition to desalting brackish water, the new membranes can be used for such industrial tasks as purifying sugar, glycerine and organic products, and for recovering chemicals from waste process streams.

Phillips gets more capital

Another producer of petrochemicals has acquired funds for expansion. Phillips Chemical, wholly owned subsidiary of Phillips Petroleum, has secured from a group of banks a $50 million credit on a standby basis. Proceeds of this loan will be used to finance important chemical projects.

Part of the funds will be used to build a plant at Houston for the production of ammonia, methanol and petrochemicals. This is the venture originally planned by the Alamo Chemical Co. Construction has already been started by Phillips Chemical. In addition, the new capital will go to finance plant expansion for production of sulphur, carbon black, pyridines and other chemicals. Phillips is a leader in petrochemicals.

Glycerine: synthetic creeps up on natural

Synthetic glycerine will account for 55 million pounds of the total estimated 1952 production of 225 million pounds of glycerine. All of the synthetic will come from the Houston, Tex., plant of Shell Chemical, sole U.S. producer. Shell recently expanded glycerine capacity there by 50 percent. Makers of fatty acids and fatty alcohols will produce from 30 to 35 million pounds of glycerine, and the rest will come from soap makers.

Shell has streamlined its process, removing bottlenecks and adding new facilities. The synthetic glycerine is made by chlorinating propylene at upwards of 500 deg. C., then converting the allyl chloride to crude glycerine, which is concentrated, desalted and purified.

Right after Korea, natural glycerine was as much as 8 c. a lb. higher than synthetic. Recently, natural glycerine has been cut to 38–40 c. a lb., making it competitive with the synthetic offered on the open market.

From a peak of 189 million pounds in 1947, production of glycerine by soap makers has dipped to about 140 million pounds a year as the advent of synthetic detergents has braked the rate of increase of soap production.

Making glycerine is currently a $100 million business. And the intramural competition between synthetic and natural glycerine is mild compared to that from other polyhydric alcohols. The total polyhydric alcohol business is currently at a billion pound a year level.

In alkyd resins, glycerine is now being challenged by pentaerythritol. Production of alkyds may reach 400 million pounds this year and 500 million by 1954. Much of Shell's output of synthetic glycerine goes into alkyds, as does a large volume of natural glycerine. But pentaerythritol capacity will climb this year to 60 million pounds a year. It sells for about 34 c. a lb., and 80 percent goes into alkyds.

Another big competitor of glycerine is sorbitol. It's penetrating the resin market and its derivatives are being used in food emulsifiers. Sorbitol capacity is expanding to 70 million pounds a year. Other glycerine competitors: ethylene glycol and propylene glycol.

Polyvinyl alcohol price trimmed

Because its new polyvinyl alcohol plant at Niagara Falls operates more efficiently, Du Pont has cut the price of its two fully hydrolyzed grades by about 10 percent. The price has been pared on both grades from 81 c. to 72½ c. per lb. for ton lots. Prices for smaller quantities are also reduced by 8½ c. a lb.

The Niagara Falls plant, completed last year, uses an improved process to make the two fully hydrolyzed grades. The partially hydrolyzed grades, which require different processing, remain unchanged in price.

Germanium: transistors spark boom for it

NEW INDUSTRY—A rival in size of the chemical industry is aborning. According to Dr. Robert M. Burns, chemical director of Bell Laboratories, it's a new electronics industry based on use of germanium in tiny amplifiers, known as junction transistors, and in miniature power rectifiers. The new germanium units are expected to replace everything from vacuum-tube amplifiers to heavy-duty power rectifiers. They'll have a big future in control instrumentation for process industries.

TRANSISTORS—A transistor is a small unit that consists of two kinds of germanium crystals, both essentially pure germanium containing minute quantities of other elements. The first kind is the positive crystal, deficient in electrons because it contains traces of such elements as boron, aluminum, gallium or indium. The second kind is the negative crystal, with an excess of electrons because of added nitrogen, phosphorus, antimony or arsenic. The junction transistor, which will replace amplifying tubes, consists either of a layer of positive germanium between two layers of

(*Continued on page 108*)

negative, or the reverse. The center layer is the control layer, similar to the grid in a vacuum tube. A typical junction transistor is about 3/16 in. in diameter and contains about 0.0002 lb. of germanium.

RECTIFIERS—Early germanium rectifiers were low-power devices. Then improved rectifiers, negative-positive units similar to the transistor, brought the power output to about 0.2 amp. at 200 v. Now even more powerful rectifiers have been made. In theory, 1 sq. cm. of single-crystal germanium will rectify 1,000 amp., and, in practice, 300 amp. has actually been rectified. This puts the germanium rectifier in the heavy-duty class, a possible competitor of the thyratron and ignitron.

ADVANTAGES—Transistors are tiny, long-lived, compact and resistant to shock. They need no warm-up, and their power requirements are low. A one-stage amplifier circuit using the transistor requires only about one-thousandth to one-millionth of the power used by an equivalent vacuum-tube circuit.

BIRTHPLACE—The transistor was born in Bell Laboratories. Now Bell's subsidiary, Western Electric, and also Sylvania, General Electric, RCA and others are busy producing transistors or improving them.

NEW TECHNIQUE—A new metallurgical technique made the transistor possible. It's the production of a crystal at a time by withdrawing it from a nearly freezing bath of molten germanium. The result is a quality control otherwise economically unattainable. Controlled addition of the trace elements to the germanium is vital.

GERMANIUM BOOM—How much germanium will this new electronics industry require? At least five times more in 1956 than last year. Manufacture of 100 million amplifying transistors in 1956 might take 20,000 lb. of germanium. But the biggest use will be in rectifiers, which will probably take twice as much germanium a year as transistors. All told, the transistor industry may require 20,000 to 40,000 lb. in 1956.

WHAT IT COSTS—Price of germanium is currently \$180 per lb. Little of it is marketed as pure germanium; manufacturers of electronic devices prefer to make their own from the oxide. Price makes little difference to them. Even at \$180 a lb., the germanium in a transistor is worth less than a nickel.

HOW IT'S PRODUCED—In the forefront of germanium production, thanks to the pioneering efforts of Dr. John Musgrave, is Eagle-Picher Lead Co. at Joplin, Mo. Most germanium produced in the U.S. comes from the smelting of germanium-rich zinc ores in the Tri-State area of Missouri, Kansas and Oklahoma. The zinc sulphide in these ores contains 0.01 to 0.10 percent germanium. Estimated zinc ore reserves in only 5 percent of the Tri-State area probably contain from 240 to 2,400 tons of germanium.

Eagle-Picher, biggest producer, gets germanium, cadmium and gallium out of the zinc concentrates by a salt roast in the Dwight-Lloyd sintering process. Germanium chloride volatizes readily and is collected for further processing.

Electrical workers short-circuited

AFL Electrical Workers failed to carve out a unit of electrical and instrument workers at the Lake Charles, La., plant of Columbia-Southern Chemical Corp. The National Labor Relations Board refused to grant the union an election because of the highly integrated and interdependent operations of the plant.

Other reasons: NLRB found that there is no clear-cut craft because other workers with diverse skills often perform the same jobs; bargaining with the AFL International Association of Machinists, moreover, had in the past been plant-wide.

California's rare earth bonanza

What may soon become the world's richest source of rare earths, the bastnasite deposit near Mountain Pass in California's San Bernardino County, is ready to be tapped. Molybdenum Corp. of America, which took over the find and recently completed test drilling (see *Chementator*, September 1950, p. 74), is all set to start production.

Molybdenum's concentrating plant has a capacity of 80 to 120 tons a day. It will begin processing at the rate of about 60 tons daily. Most of the technical problems for handling the ore have been worked out successfully.

Bastnasite is the fluocarbonate of cerium and lanthanum. Its importance as a source of cerium and lanthanum is heightened by the fact that Brazil and India have largely cut off their shipments of monazite sands to the U.S.

Rare earths are used in arc lamps, tracer bullets, luminescent shells, lighter flints and special chemicals. Vast new uses for the metals are appearing, however. Rare earths are valuable alloying agents for improving the high-temperature performance of steel and other metals for jet engines. And they have important roles in the atomic field.

In steels, rare earths improve the quality of the final product, and they reduce the cost of heating, rolling and drawing.

Molybdenum's lease covers about 20 acres, with some bodies reportedly ranging up to 40 percent rare earth minerals. In addition, some 20 percent of the entire lode is barite, important to the petroleum industry for the manufacture of drilling mud. There is little overburden, and the deposit is expected to be worked by diesel shovel.

Rare earth production marks the beginning of a new California industry. The new find, because of its size and accessibility, is expected to open up a whole new field of uses for the rare earths.

—*End*

POPCORN or PLASMA... It's delivered in PAPER

Bright, attractive and sellable . . . tough, weatherproof and functional, in the foyer or at the front, paper delivers the goods. Properly, paper ranks with America's most essential industries and similarly, production requires ever-greater quantities of chemicals.

Closely associated with the paper and pulp industry for 60 years, Mathieson today supplies more basic chemicals than ever before. Today, Mathieson is the only manufacturer that can furnish all the following—caustic soda, soda ash, bicarbonate of soda, liquid chlorine, ammonia, sodium chlorite, sulphur, nitrate of soda, ammonium sulphate, sulphuric acid, hypochlorite products, diethylene glycol and triethylene glycol.

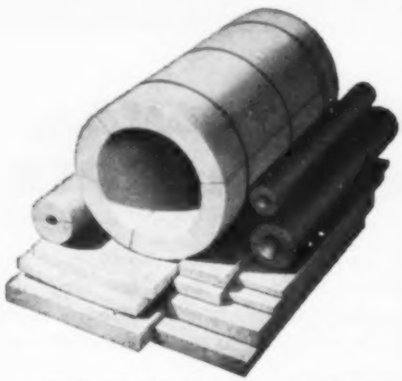
Currently, with certain of these chemicals critically short, a dependable source of supply is increasingly important. You may find it to your advantage to discuss your requirements with us now. Mathieson Chemical Corporation, Baltimore 3, Maryland.

Mathieson CHEMICALS

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

Does Your Present Heat Insulation Have All These Advantages?

Kaylo Heat Insulation is a hydrous calcium silicate — a revolutionary heat-saving material — outstanding both in performance and ease of application.



KAYLO PIPE INSULATION is made to Simplified Dimensional Standards of thicknesses and diameters for snug nesting, when necessary.

1 **LOW "K" FACTOR**—Billions of sub-microscopic air spaces which compose the structure of Kaylo Heat Insulation give it exceptional insulating value.

2 **TEMPERATURE RANGE UP TO 1200° F.**—Kaylo Heat Insulation eliminates the need for combination coverings in nearly all operating conditions.

3 **LONG SERVICE LIFE**—Kaylo Heat Insulation remains dimensionally stable, strong and efficient over the years—although exposed to temperatures up to 1200°F.

4 **INSOLUBILITY IN WATER**—Even when saturated, Kaylo Heat Insulation retains about 85% of its strength. It returns to its original strength after drying.

5 **HIGH STRENGTH**—Breakage of Kaylo Heat Insulation is almost negligible in shipping and installation—workmen can walk on insulated equipment without causing breakage.

6 **LIGHT WEIGHT**—Since Kaylo Heat Insulation weighs only 11 pounds per cubic foot, it is exceptionally easy to handle and apply.

7 **WIDE RANGE OF SIZES AND SHAPES**—Kaylo Heat Insulation's unmatched selection of sizes and shapes reduces the number of pieces required per job.

8 **EASE OF CUTTING AND FITTING**—Ordinary tools of the trade are used to install Kaylo Heat Insulation. The material is non-irritating to the skin and non-toxic.

For complete details on all of the advantages of Kaylo Heat Insulation, write Dept. N-256, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO® . . . *first in calcium silicate*

. . . *pioneered by* OWENS-ILLINOIS Glass Company

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DETROIT • HOUSTON • MINNEAPOLIS • NEW YORK • OKLAHOMA CITY • PHILADELPHIA • PITTSBURGH • ST. LOUIS • WASHINGTON

This series of advertisements is presented in the belief that there are chemical, metallurgical and other engineers who will find in some of the properties of Super Refractories by CARBORUNDUM the key to new or more effective uses of heat—and of refractories. We would like to talk over specific jobs with anyone who sees such possibilities.

Here's a refractory as rapidly as

Super Refractories by CARBORUNDUM possess a number of interesting properties not usually associated with refractory materials—properties that can be used to obtain unusual results.

Among these products are CARBOFRAX silicon carbide refractories. And one of their unusual characteristics is high heat conductivity. *At elevated temperatures, this property closely approximates that of nickel-chromium alloy steels.*

This characteristic has led to interesting applications. For example, it is not obvious that high heat conductivity is an advantage in checker brick—but it is. CARBOFRAX brick, when used in checker work, absorb—and deliver—two to five times as much heat as fireclay brick in a given period of time. You can recover more heat with fewer brick (and therefore with smaller regenerators, less pressure loss.) Or you can get higher temperatures if you want them. Even one or two rows of CARBOFRAX brick will often make a lot of difference.

Among other applications where high thermal conductivity is important: Tubes and tile in recuperators. Muffles or hearths in heat-treating furnaces. Water-wall boilers, where CARBOFRAX shapes protect the tubes while transmitting heat to them. Even arc shields on circuit breakers, where CARBOFRAX plates help quench the arc by conducting heat from it.

In the box below you'll find other characteristics of this unusual material. Do any of these suggest applications to you? If so, we'd like to discuss them with you, either in person or by letter. Won't you write or call us at Perth Amboy, N. J.?

These are some of the characteristics of CARBOFRAX Super Refractories

- They readily withstand temperatures up to 2800°F and under certain conditions up to 3200°F.
- Their resistance to abrasion is excellent. (An application: In slab-heating furnaces, CARBOFRAX skid rails have proved superior to alloy steel and water-cooled pipes.)
- They are far stronger, in all temperature ranges, than practically all other refractories.
- In most cases, they'll outlast ordinary refractories many times.
- The coefficient of expansion is very low—.000005 per degree C between 25° and 1400°C. Spalling is rarely experienced.
- They remain extremely hard at most furnace temperatures, and therefore offer no footing for clinker or slag accumulations.

that **CONDUCTS** heat
chrome-nickel steels

Could you use this material to get . . .

- highly efficient vertical retorts?
- more effective muffles and hearths?
- more productive regenerative equipment?
- better heat transfer in any process involving either high or moderate temperatures?

CARBOFRAX refractories are available as brick and as special shapes molded to very close tolerances—including fitted joints, tubes, etc. They are not, however, a universal cure-all, and should be applied with caution where iron oxides or basic fluxes are present at high temperatures. Under such conditions, other CARBORUNDUM Super Refractories, particularly MULLFRAX electric furnace mullite or ALFRAX electrically fused alumina, will probably prove better fitted.

We have a booklet which outlines all Super Refractories by CARBORUNDUM. You'll find information about refractory materials which, for example, are chemically inert, or highly erosion resistant, or light in weight, etc.

The "custom-made" qualities of these special purpose refractories may go hand-in-glove with your uses of heat. Why not check up? The coupon will bring you the story—or one of our engineers will be happy to talk over possibilities. We believe it could be mutually profitable.

THE CARBORUNDUM COMPANY
Refractories Division Perth Amboy, N. J.

"Carborundum," "Carbofrax," "Mullfrax" and "Alfrax" are registered trademarks which indicate manufacture by The Carborundum Company.

Dept. H-32
Refractories Div., The Carborundum Co.
Perth Amboy, New Jersey
Please send your free booklet on Super Refractories
Name __________
Position __________
Company __________
Street __________
City __________ Zone ____ State ______

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.

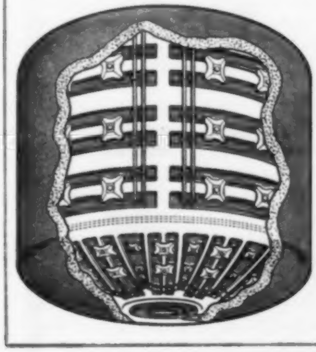
Industry's Most Versatile Heat Source

Chromalox *Electric*

Strip Heaters

Easy to Install CHROMALOX Electric Strip Heaters give clean, dependable and accurately controlled heat where and when heat is needed. They produce uniform and accurate temperatures by automatic or manual controls. Low initial costs, low installation costs and low operating costs are among the many advantages of using CHROMALOX Strip Heaters for heating liquids, gases, viscous fluids, tanks, platens, molds, moving parts, etc. Get the full details now.

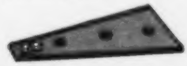
A Typical Strip Heater Application from Our Files



Rugged, easily installed Chromalox Strip Heaters assure accurate temperature, dependable around-the-clock service.

Strip Heaters curved slightly as installed conform to shape of convex kettle bottom, while . . .

Strip Heaters curved lengthwise at the factory fit snugly to tank perimeter and . . .

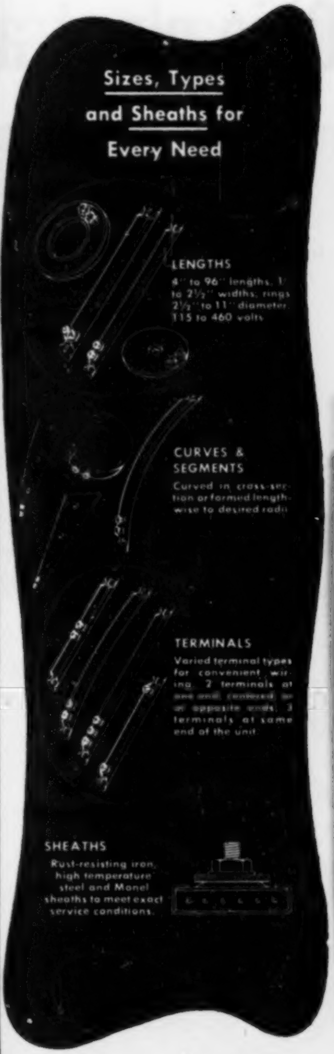


Segment Heaters fill the gaps.

IC-99

CHROMALOX

Electric Heat for Modern Industry



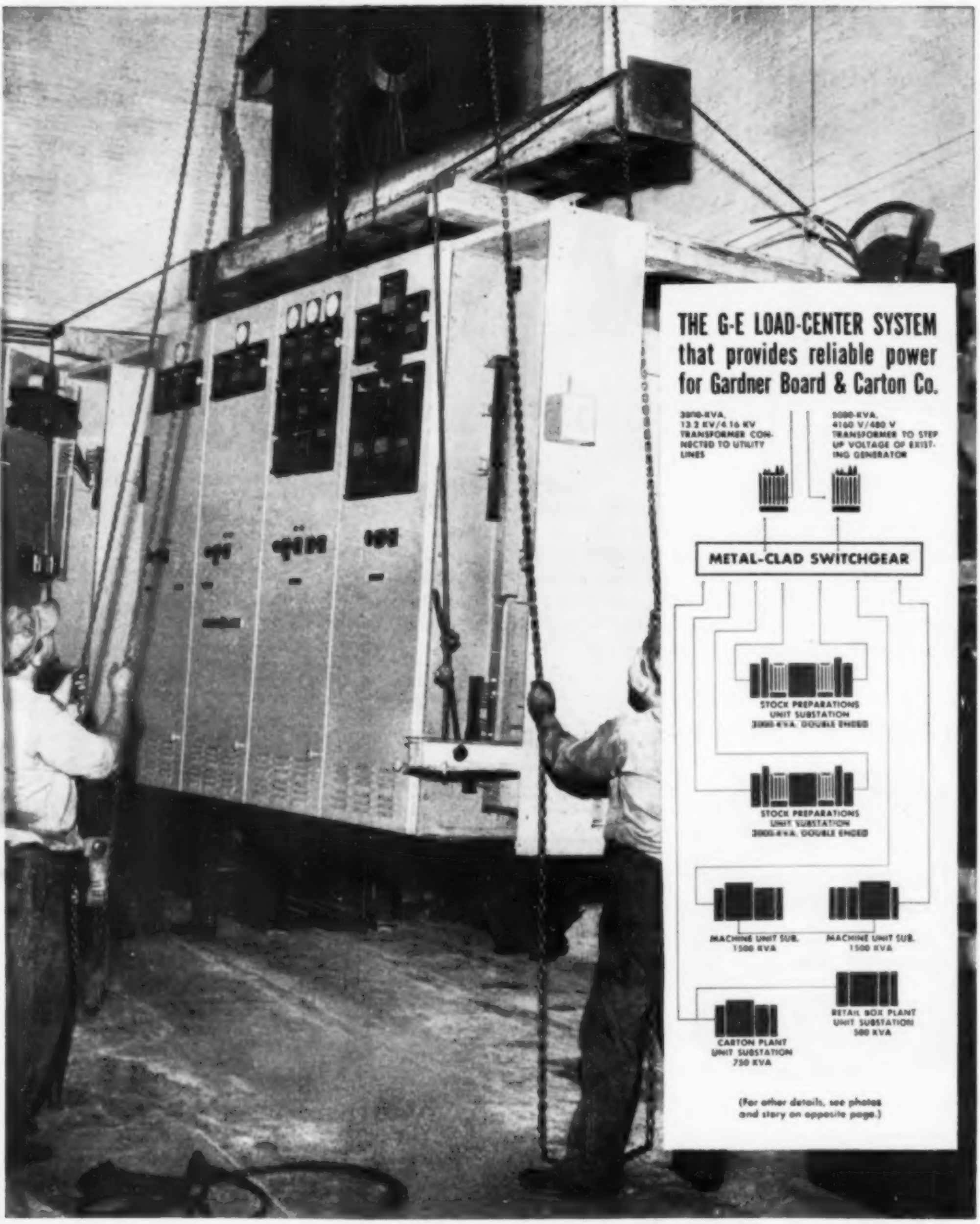
Want Ideas?

on how to use Chromalox Electric Heaters in your plant

Write for the data-packed Catalog 50 which describes many types of Chromalox Electric Heaters and how to apply them. It's yours without obligation.

EDWIN L. WIEGAND COMPANY
7514 Thomas Blvd., Pittsburgh 8, Pa.

Ohio plant avoids shutdowns with



G-E FACTORY-ASSEMBLED POWER EQUIPMENT IS EASY TO INSTALL. HERE MEN LOWER MAIN SWITCHGEAR SECTION INTO PLACE.

G-E load-center power system

Like many other growing plants, the Gardner Board and Carton Co. found they needed more power. They realized, too, a pressing need for more protection against power-failure shutdown than they had with their old-type 480-volt distribution system.

How they did it: With the help of General Electric engineers, Gardner completely replaced their old 480-volt system with a modern 4160-volt G-E load-center system. Compact, metal-enclosed unit substations now give them plenty of power—and plenty of protection against power shutdowns too. A secondary-selective system provides duplicate sources of power for substations supplying the most vital plant loads. Metal-enclosure of all live parts—and modern breakers with plenty of interrupting capacity—give further protection both for production and for plant personnel.

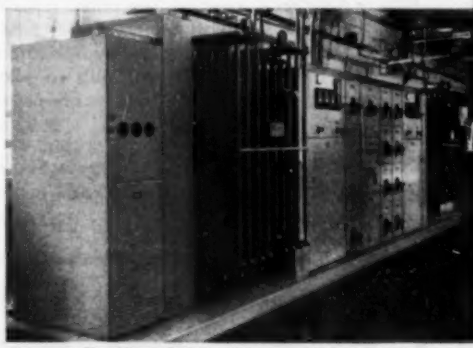
Improves Voltage—Saves Copper—Flexible for Future

By taking high-voltage power directly to load centers, long secondary circuits are avoided, and plant voltage improved. The tons of extra copper that would have been required to expand the old 480-volt system were saved. And the plant electric system now has great flexibility for the future. Additional substations can be added easily, quickly, economically. Existing ones can be easily moved to follow load shifts.

For further information on G-E engineered load centers, call on your local G-E sales representative, or write for GEA-3592, General Electric Company, Schenectady 5, N. Y.

G-E "Project Co-ordination" praised by Chief Engineer

"Many costly man-hours were saved for us by G-E over-all co-ordination," says Arthur Harvey, Chief Engineer of Gardner Board and Carton Co. "From planning to final installation, G.E. co-ordinated all equipment and delivery details whereas Gardner men installed the equipment. The effect on our production during this period was negligible." In photo above, Mr. Harvey discusses over-all plan submitted by General Electric with Mr. J. M. Popp, G-E sales engineer. A simple outline of this plan is shown in chart on opposite page.

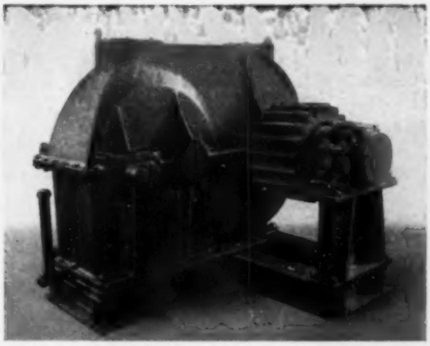


Compact Double-ended Load-Center Unit installed close to load. Ratings: 3000 kva, 4160/480 v. Drawout breakers are easy to inspect, have plenty of interrupting capacity. Note G-E "Interlocked Armor" cables, which provide metal-enclosed circuits with lower material and installation costs.

GENERAL ELECTRIC

321-78

Vulcan is equipped to produce cast-steel gear rings, with machine-cut teeth, up to 24 ft. in diameter and 40" face.



Enclosed type of Speed-Reducer Drive Unit now usually provided for Vulcan Kilns. Old-style open-type drive units are still furnished when required for replacement on older kiln installations.

Typical Replacement Tire Section being finished up for shipment from a Vulcan Shop. Tire is one-piece steel casting.

NOW IS THE TIME TO ORDER

REPLACEMENT PARTS

for your Rotary Kilns, Coolers, Dryers, Retorts, Etc.

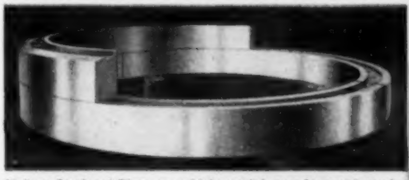
At the present time we can still make reasonably prompt delivery on all of the various types of replacement parts here illustrated and described. No one can foretell the future but why take chances? If you are not already equipped to make quick replacement of all worn or weak parts you have everything to gain and nothing to lose by placing your orders NOW.

There are other good reasons why you should order replacement parts from Vulcan. Fifty years of widely varied experience, backed by a large steel foundry, an equally extensive steel fabricating plant and ample machine shops, especially equipped to handle large work, enable us to give superior service at competitive prices. Estimates submitted promptly on receipt of adequate working data.

VULCAN IRON WORKS

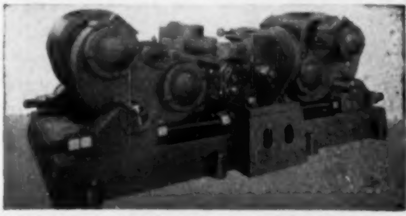
WILKES-BARRE, PA.

BRANCH OFFICE, 50 CHURCH ST., NEW YORK, N. Y.



Vulcan Sectional Tires are widely used for replacement service and usually permit important savings in installation expense. Available in all sizes, for light or heavy service.

Standard Vulcan Assembly of Supporting Roller Bearings and Thrust Bearings for Rotary Kiln. Other types available for lighter service and also for very heavy service.

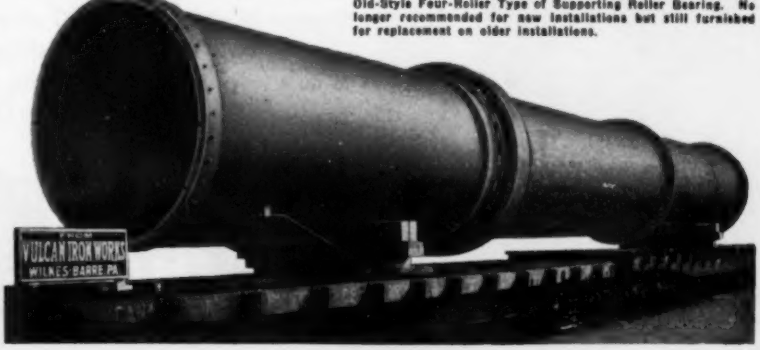


Old-Style Four-Roller Type of Supporting Roller Bearing. No longer recommended for new installations but still furnished for replacement on older installations.

Vulcan Welded Kiln-Shell Section ready for shipment. Shells or shell sections can be of any diameter up to the limit of railroad clearances. Unless otherwise specified all longitudinal joints are automatically welded. Intermediate circular joints are usually U-grooved and electrically welded, with suitable outside reinforcements.

Vulcan Shell Sections can be arranged for either field welding to the old sections of the shell or, if preferred, for field riveting to present circular butt straps.

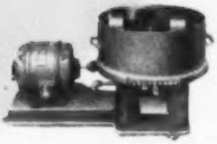
Shell sections can be furnished complete with tires and reinforcements attached to the section.



SIMPSON *MIX-MULLERS*

No. 00 Mixer—24" pan dia.
1½ hp—1200 rpm
¼ to ⅓ cu. ft. capacity

No. 0 Mixer—3' pan dia.
5 hp—1200 rpm
1 to 1½ cu. ft. capacity



Laboratory Mixer—24" pan dia.
1½ hp—1200 rpm
⅙ to ½ cu. ft. capacity

12 BASIC MODELS

Laboratory Mixer—18" pan dia.
¾ hp—1800 rpm
1/10 to ⅙ cu. ft. capacity

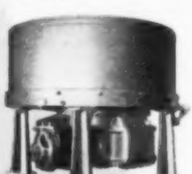
EACH ASSURING FASTER, MORE ACCURATE *MULLING* OF DRY, SEMI-DRY, AND PASTY MATERIALS

SIMPSON Mix-Mullers are built in 12 basic models to fit practically every mixing requirement. Having a capacity range of from 1/10 to 60 cu. ft., each of these models can be equipped for mixing under pressure or vacuum—for heating or cooling—for mixing corrosive materials—or to function as a reaction vessel as well as a mixer.

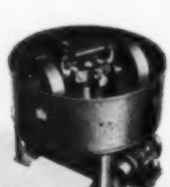
Each model incorporates the *true mulling principle* that has proved so successful throughout the chemical process industries—wherever accurate, controlled mixing and blending of materials is a necessity. The simple rugged design assures low operating and maintenance costs, as well as rapid mixing with a minimum of horsepower consumption per ton of material mixed. The accurate control afforded by batch mixing in a Simpson Mix-Muller is readily adapted to continuous systems.

FOR PROOF of the ability of Simpson Mix-Mullers to do a *better, faster* job in mulling your material—investigate our FREE LABORATORY SERVICE.

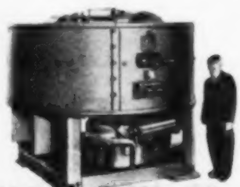
No. 2 Mixer—6' pan dia.
15, 20 or 25 hp—1200 or 1800 rpm
12 to 15 cu. ft. capacity



No. 3 Mixer—8' pan dia.
40 or 50 hp—1800 rpm
25 to 30 cu. ft. capacity

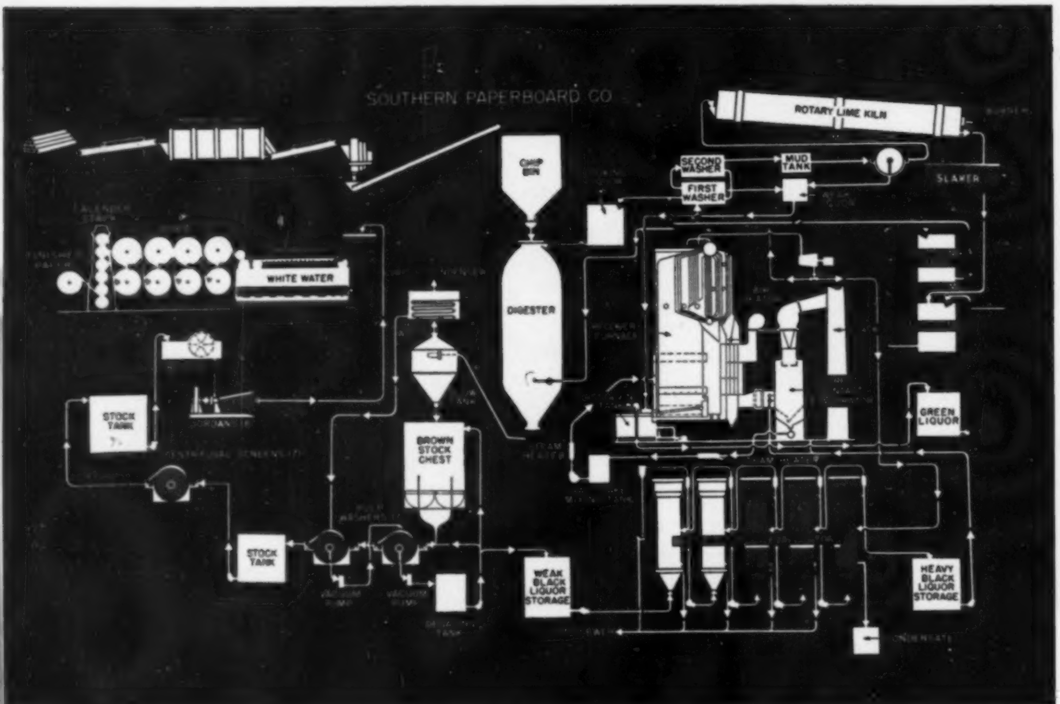


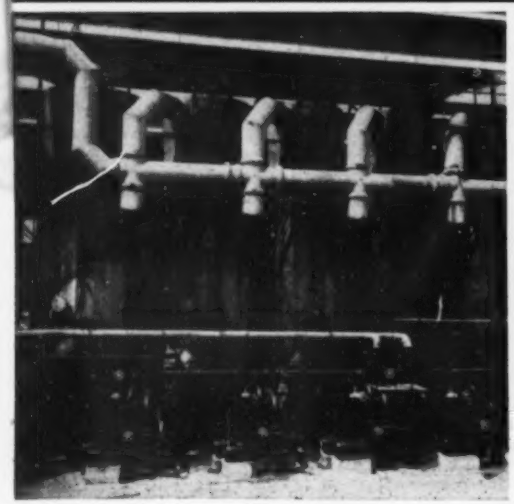
New No. 2F Mixer—6' 8" pan dia.
25 to 30 hp—1800 rpm
30 cu. ft. capacity
(Note adjustable muller design)



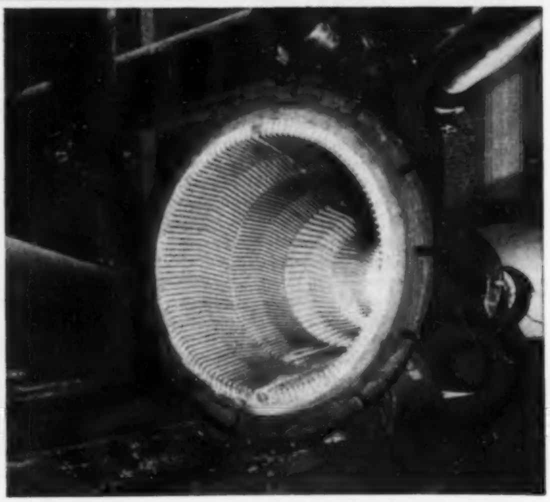
New No. 3F Mixer—8' 4" pan dia.
60 to 75 hp—1800 rpm
60 cu. ft. capacity
(Note adjustable muller design)

How SOUTHERN PAPERBOARD

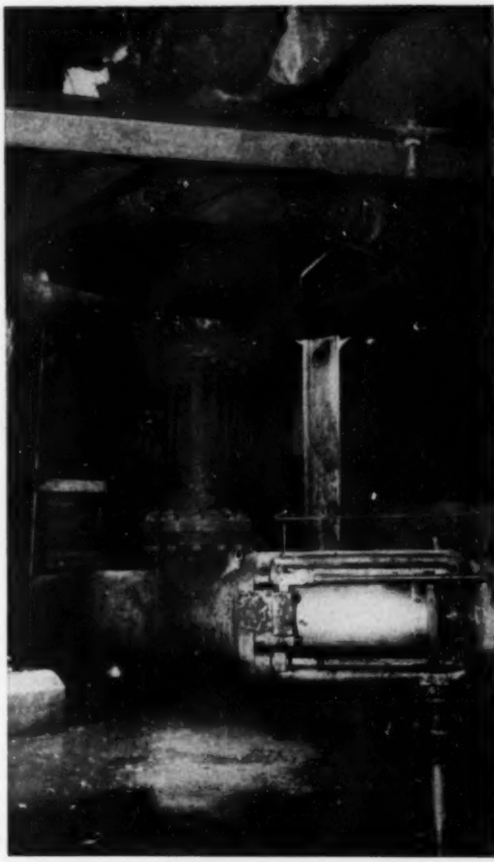




The first three effects of this multiple-effect evaporator each contain 1,050 2" x 22' Stainless Steel tubes. In the first effect, Stainless has already outlasted the material it replaced, and appears good for many months of additional service.



Stainless Steel bars in one of the 14 Jones Majestic Jordans in Southern Paperboard's mill. Bars are sanded and straightened about every 18 months, but their service life is considered almost indefinite.

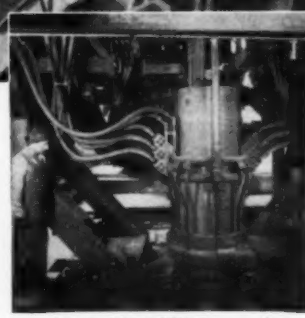


This Continuous Process
demanded
CERTAIN PERFORMANCE

Two size "M" Lectromelt Furnaces melt cathodes to keep this copper refinery in continuous operation. A third, not shown, melts anode scrap.

So for the melting part of this electrolytic copper refinery operation, the logical choice was Lectromelt*. Because from the electrical brain that guides its operation to the massive shell of the furnace itself, Lectromelt is built to be a production tool. It will give you long, trouble-free service and correspondingly low-cost operation (we sell mighty few replacement parts).

For smelting or melting, refining or reducing—Lectromelt engineers will help you design your process and tailor-make the installation to your needs. Write for your copy of "Moore Rapid Lectromelt Furnaces for Smelting and Refining Operations," Pittsburgh Lectromelt Corporation, 325 32nd Street, Pittsburgh 30, Pa.



A typical 1500-KVA Lectromelt smelter at charging floor level. Three electrodes in line.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . AUSTRALIA: Birlec, Ltd., Sydney . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa.

*REG. T. M. U. S. PAT. OFF.

WHEN YOU MELT... MOORE RAPID *Lectromelt*

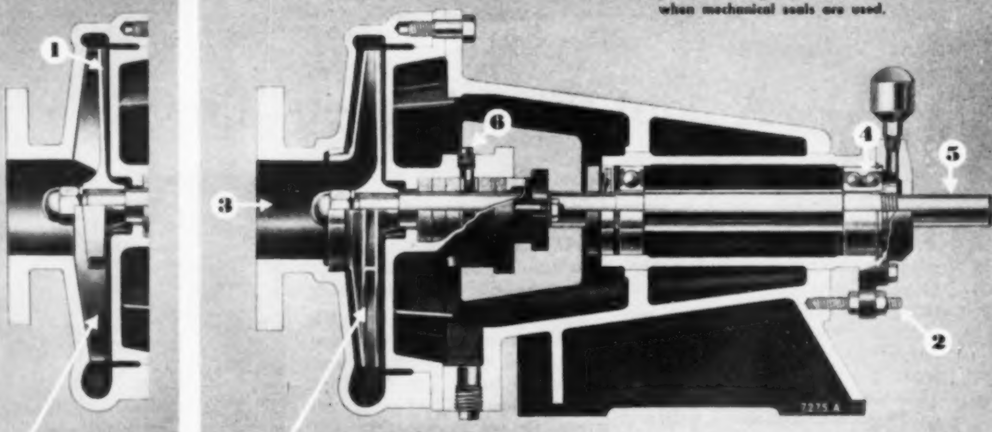
50 K.V.A. TO 50,000 K.V.A.

DE LAVAL CP PROCESS PUMPS *designed*

Look at these design extras

SIZES TO 6"
CAPACITIES TO
1800 GPM
HEADS TO
200'

1. *Eductor vanes* on the back of open impellers develop higher pressures than pumping vanes. This reduces end thrust, relieves stuffing box pressure, keeps back of impeller clean and prevents binding.
2. *Rotor adjusting screw* makes it simple to pull the impeller off the shaft. No special tools are needed.
3. *Large throat diameter* keeps entrance velocities low . . . lessens the danger of cavitation.
4. *Husky double row* ball thrust bearings insure long uninterrupted service.
5. Heavy stainless steel *shaft* is designed for severe operating conditions.
6. *Inlet-outlet water seal connections* provide sealing liquid and cooling when mechanical seals are used.



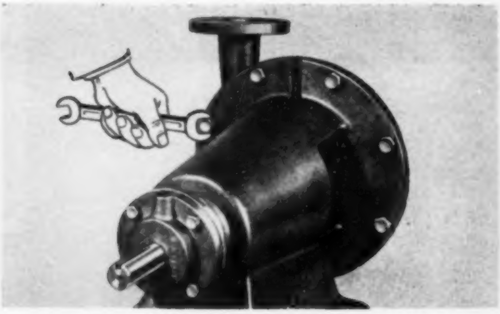
OPEN IMPELLER **CLOSED IMPELLER**

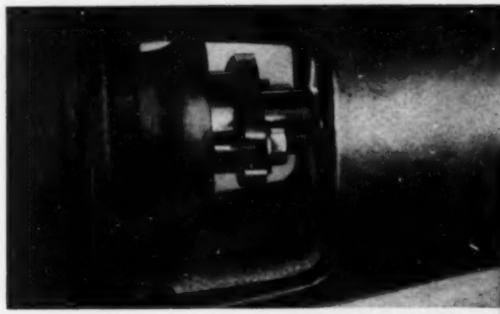
De Laval CP Process Pumps are *versatile* on many counts. Impellers and seals can be quickly switched to meet changing service requirements. Adjustments for wear are simple to make. Repair parts are standardized. And, in addition, these pumps are specially designed for hundreds of general service process applications.

Careful selection of proven corrosion resistant materials permit CP pumps to handle practically all types of acids and alkalies. Whether liquids are hot or cold, viscous or corrosive, clear or filled with suspended solids, these pumps will keep giving efficient service for years.

Whatever your processing application, it pays to investigate the De Laval line of double-duty CP pumps. Bulletin 1125 gives complete data on these pumps, tells why they are . . . DESIGNED TO STAY ON THE LINE.

for double-duty performance





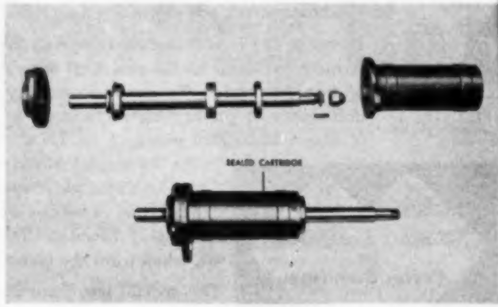
TWO PUMPS IN ONE! When service requirements change, you can *quickly* convert these pumps from closed to open impeller—and back again! As the cutaway drawing shows, all you need do is switch the pump volute and impeller. *There's no need to buy a whole new pump!*

YOU CHOOSE THE SEAL! You can specify either mechanical seals or flexible packing . . . and change from one type to another *in your plant.* Gland faces are pre-machined and drilled for easy conversion to mechanical seals. Area around gland is large, easy to work in.

...and for time-saving maintenance

HERE'S EXTRA PUMP LIFE! On *closed-type*, turning the external adjusting screw moves entire rotor and impeller forward, permits you to adjust for proper clearance between case and *tapered* wearing ring. On *open-type*, simply face off worn parts of impeller and case, re-assemble pump and reposition impeller with adjusting screw.

DOUBLE-DUTY REPAIR PARTS! Two sizes of shafts, shaft lock-nuts, bearings, bearing cartridges and pedestals fit *all nine sizes* of De Laval CP Process Pumps. This versatile feature is another of the many De Laval design advantages that help trim costs by keeping your stock of repair parts at a minimum.



DE LAVAL *Process Pumps*

DE LAVAL STEAM TURBINE COMPANY
TRENTON 2, NEW JERSEY

DL-128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THE RIGHT EQUIPMENT
For Every
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If your requirements include the Chemical Processing of solids, semi-solids or liquid materials, you can be sure of volume production and exacting results thru INTERNATIONAL PROCESSING EQUIPMENT—*the kind that pays dividends* and provides dependable, uninterrupted service over long periods of time.
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MFRS. OF CHEMICAL PROCESSING EQUIPMENT, VENTILATING FANS, STACK FANS, AXIAL BLOWERS, BRICK, TILE, POTTERY AND CERAMIC MACHINERY

Memo from the Editor John R. Callaham

We go through Emery's plant with Works Manager John Archiable (center).

Our Cincinnati Experiment

Last month we tried something new —an "editors' holiday." You may think this smacks a little of the famous "postman's holiday," and you're right.

It's second nature and a tradition with our editors to travel, to visit plants and laboratories all over the country (some of us average 10,000 miles or more every year). That's our way of keeping on top of things.

But for our "editors' holiday" six of us decided to pick up and go to Cincinnati for a week just to see and learn. We wanted to get the feel of things at the "grass-root level" without being bothered with having to write something.

So off we went by plane and train to meet again at the Terrace Plaza, Cincinnati's modernistic, push-button hotel. And next time you're in that city, try the Terrace Plaza. It's an adventure, what with all the buttons and gadgets. By the week's end I had the habit of taking a little ride on the motorized couch-bed every night before going to sleep.

One of our first calls was on Eagle-Picher Co. We learned about that firm's wide-spread activities in the mining, insulation and pigments fields.

But the most fascinating story was on germanium and how Eagle-Picher produces it by a series of purification steps. Germanium's the rare metal that has recently been tagged as "one of the most revolutionary developments in the electronics field since the vacuum tube."

The first afternoon Ray Katzen, assistant manager of Vulcan's engineering division, gave us a tour of Vulcan Copper & Supply's plant and offices. There we saw Vulcan's expanded engineering division and learned about some of the things it's doing in plant design and process development. Ray showed us the ethylene oxide pilot plant as well as the fabrication shops. I was surprised to see the size and complexity of some of the distillation columns being put together. The Vulcan people certainly use a bagfull of ingenious tricks.

That evening we had a private dinner with about a dozen or so people representing a cross section of chemical industry and education.

This was an informal, off-the-record, let-your-hair-down, give-and-take affair. We chatted about industry problems and what was being done about them. We asked how we could do our part better, and got some mighty frank answers.

All in all, I gathered that the technical manpower squeeze is about the most thorny problem that the chemical industry faces. Government regulations and pollution problems run a close second.

One of the most stimulating parts of this evening session came when we led off with the "what's-wrong-with-us?" question. Here again, we asked for and got frank answers that'll help guide us in the future.

Early next morning we got together again for a turn through the plant of Emery Industries, one of the world's largest producers of fatty acids and its derivatives. Emery started off in this business in 1840, made history with the Twitchell process for hydrolyzing fats. The company has recently put up two new continuous, high-pressure hydrolyzers and hopes to put up another one soon.

More than a dozen Emery officials had lunch with us, after which we spent several hours in an off-the-record, question-and-answer session. The Emery people told us what they were doing in the way of developing new products and processes, some of which are about ready to be taken out of wraps. In turn, we told them what we are trying to do and some of the problems we have.

That evening, V-P Bill Heilig of Wm. Powell Co. was kind enough to invite all of us en masse for a couple of hours of cocktails at his home. Bill's "den," which he built himself in his basement, is really something to see and enjoy. Between cocktails, the conversation gravitated to corrosion-resistant valves and the work that Powell is doing in that field.

Highlight of the next day's plant trips was the visit through Procter & Gamble's huge factories in the Ivorydale area.

From the processing standpoint, the most interesting operation to me was the highly efficient plant for turning out Dreft and Tide synthetic detergents. P & G uses the sodium reduction method at Ivorydale.

But from the standpoint of sheer mechanical ingenuity, nothing I've seen in a long time can hold the candle to the soap finishing and packaging operations. Some of those machines can yank out a folded box, fill it and seal it faster than your eye can figure out what it's all about. Timing must be just so or everything really gets into a mess.

The remainder of the week pretty much followed the pattern for the first day's schedule: office visits, plant trips, lunches and dinners with industry representatives, interviews with subscribers, business talks with company officials, technical talks with engineers.

All in all, I figure that we talked to 107 chemical people in the Cincinnati area—from company presidents to mar-

(*Continued on page* 147)

SIDNEY D. KIRKPATRICK, Editorial Director JOHN R. CALLAHAM, Editor

Chemical Engineering

WITH CHEMICAL & METALLURGICAL ENGINEERING

MARCH 1952

What About Manpower for the Longer Pull?

Forward planning is not new in most chemical industries. If evidence is needed just recall the figures given in McGraw-Hill's fifth annual survey of management's plans for capital expenditures. Four out of five of the chemical companies make it a regular practice to plan expansion and modernization for at least three, often five years ahead. Their spending, incidentally, is scheduled to continue at a high level through 1955, at which time they plan to put out just about as much money as they did in 1951. All this is most encouraging for the industry and the national economy. But it does raise this question:

Assuming we can get the steel and labor—and money—to build and equip $5 billion worth of chemical plants during the next four years, where will we get the engineers and technical manpower to run them?

It's high time that industry does some long-term hard-headed planning for its organizational needs. And because this is a problem of vital concern to engineers and technologists, as well as to top management, we all have a share in the responsibility for its solution.

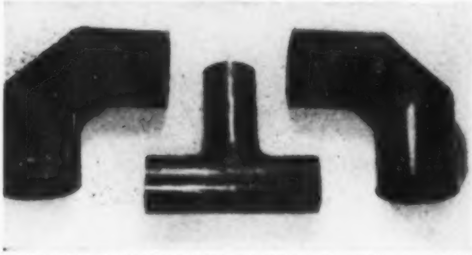
Meeting last month at MIT for the fourth College-Industry Conference, more than 300 serious-minded engineering educators and industrialists came to grips with this perplexing problem. All agreed that long-range planning is absolutely essential. The present shortage of engineers cannot be alleviated by formal education alone in less than 10 or 12 years. It must start in the secondary schools where peak enrollments have not yet reached the fifth and sixth grades. Early interests in science and engineering must first be developed among 10-to-12-year old youngsters. Vocation patterns are most often set during the first two years of high school. Here then is our best reservoir for a new supply of technical manpower, but we should do something to increase the stream that flows to the colleges and, more importantly, the percentage that actually completes their prescribed courses. Today 21 percent enter college and only 11 percent are graduated; yet according to Dr. Morris Meister of the Bronx High School of Science, at least 33 percent of high-school graduates could qualify for higher education and from this number we could expect a 50 percent increase in the number of college graduates.

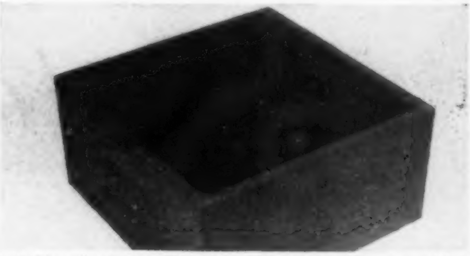
President Jess H. Davis of Stevens Institute of Technology sees hope for better development of the engineer as an individual during the four years he spends in college. The most common weaknesses he finds in engineering students are in the fields of communication and human relations and in the lack of judgment outside of a narrow speciality. He suggests more use of the case method to help in correcting and correlating many of the personal factors now overlooked in the education of the engineer for industry.

But, as always, the biggest share of the load is squarely on the shoulders of industry. Henry N. Muller of Westinghouse lists these "musts" in any worthwhile program of management development: (1) Early and thorough orientation of the young man to his job; (2) a good training program to close the gap between college and industry and to correct deficiencies and unhealthy attitudes; (3) continued education through graduate study programs; (4) opportunity and encouragement to participate in community affairs; and (5) a program to promote professional growth and development. Most important of all is that we use all the human resources we have most resourcefully.

If it is sound business practice for industry to lay out plans for the plants and equipment for new processes and products in the years ahead, it is equally essential that management should program its needs for technical manpower. All of our long-range planning can prove unrealistic and impractical if we do not somehow provide for our future supply of engineering and scientific personnel. There are nearby high schools and colleges where your advice and support will help most in the long pull. But in the meantime better start now within your own organization your own program for management and professional development.

Sidney D. Kirkpatrick





THERMOSETTING—Polyfurfuryl alcohol pipe with cemented joints (left), and cast phenolic tank cured at room temperature (right).

THERMOPLASTICS—Rigid polyvinyl chloride duct with welded flanges (left), and hood of rigid polyvinyl chloride (right).

Plastic Processing Equipment Today

What you should know about thermosetting and thermoplastic materials that are showing up in ever increasing amounts in pipe and fittings, duct work, tanks, and valves.

RAYMOND B. SEYMOUR and JAMES H. FRY

Fabrication:

Thermosetting Plastics

While chemical equipment based on cast asbestos-filled phenolic resins has been available and used successfully with non-oxidizing acids for over 20 years, it lacked versatility since it was attacked by alkali. Fortunately, this deficiency has been overcome, at least in part, through the introduction of equipment based on filled cast furfuryl alcohol resins.

Equipment from either type of resin may be cast in inexpensive wood or metal molds and cured at ordinary or slightly elevated temperatures and pressures. In the casting process, an intimate mixture of a suitable filler, catalyst and liquid resin is deaired and placed in a mold for 2-10 hr. or until the mortar has become hard. The plastic object is then allowed to stand for several days and is then trimmed or machined.

The size of equipment produced is essentially unlimited but large structures are usually built in small units and assembled using flanges and bolts or by cementing the parts together with the original mortar. It is customary to build cylindrical units with diameters as high as 10 ft. and a maximum height of approximately 8 ft. and to cast rectangular units as long as 15 ft., with a maximum width and depth of 8 ft. and 5 ft. respectively. Units weighing as much as 2 tons before assembling have been built and used industrially.

Structures fabricated from phenolic or furfuryl alcohol resins may be readily machined using adaptations of techniques well known to the wood and metal industries. In designing vessels, an allowance for a shrinkage of 0.3-0.5 percent is made and a factor of safety of 5 is customarily used. Too thin or too thick sections and sharp corners are usually avoided. The structures are heat stable and will not be distorted by heat up to the characteristic temperature limits.

TANKS

Rectangular tanks are usually reinforced externally by means of steel angles while cylindrical vessels are strengthened through the use of wooden staves and metal hoops. Phenolic and furfuryl alcohol resin cements are available for patching tanks made from these materials and in some instances such products have been used for the fabrication of equipment in the field. These products have a weight

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advantage in that they are approximately ⅓ as heavy as cast iron and as previously indicated, can be cast to form a wide variety of intricate shapes.

PIPE

Almost any castable resin may be used to manufacture pipe using centrifugal casting, stationary casting or rotary mandrel techniques. Such pipes may be reinforced using acid digested asbestos or chemical grade glass fibers in mat or woven form.

One commercially available type of asbestos-filled phenolic pipe is a heavy product available in standard lengths of 4 to 10 ft. in sizes ranging from ½ to 12 in. I.D. It is joined by means of a split metal flange held in place by a tapered groove which obviously weakens the pipe. Plastic pipe is also available with bell and spigot ends. However, joints as corrosion resistant and as strong as the pipe itself have been secured by butting straight end pipe and wrapping with fiber glass impregnated with the same cement as that used to make the pipe itself. The wrapping technique has also been used to reinforce and protect pipe made of porcelain.

In designing thermosetting plastic pipelines, allowances must be made for loss in strength with temperature and the pipe must be supported at intervals so that the maximum span between supports is less than 5 ft. Factors of safety as high as 10 are occasionally used and expansion joints must be provided if the line is subjected to large differences in temperature and does not have free lineal movement from at least one end.

Thermoplastics

Because thermoplastics can, by definition, be heat-formed, they lend themselves to easy fabrication methods such as extrusion, blow-welding, molding, drawing, flame-spraying and melt-casting. The thermoplastics that have been utilized most thoroughly for fabrication are polymethyl methacrylate, polyethylene, Saran and polyvinyl chloride.

All four of these materials have been extruded to form pipe or rod and these forms can be utilized for further fabrication. For example, bolts are made by machining round rod, and nuts can be produced by tapping cross-sections of square rods using techniques which are standard in the metal fabrication field.

Polyethylene has been widely used for spraying and spin-casting. The economics of spraying usually rule against this technique when the article required can be formed by extrusion or calendering processes, but spraying has met with some success in field applications. Spin-casting is essentially a modification of the spraying process in which granular polyethylene is distributed in a rotating tube at 450-500 deg. F. and allowed to cool. The size of the pipe manufactured by this technique is limited only by the size of the hot tube used for the casting procedure. Spun-cast tubing may be slit in order to make sheets of various thicknesses.

MOLDING

Considerable amounts of polyethylene are used in the blow-molding process which is essentially a modification of the extrusion process. Likewise, considerable quantities of polyvinyl chloride may be used for slush-molding. In this process, a plastisol which is essentially a dispersion of polyvinyl chloride in a liquid plasticizer, is poured in a suitable mold which is then heated in a stationary or rotating position for a short period of time in order to fuse the plastisol closest to the mold surface. The residual liquid plastisol is then poured out and the curing process is continued for a short period of time. The thickness of the slush-molded articles is a function of the time and the temperature of the preliminary curing step. Since plastisol fabrication takes place with very little shrinkage, excellent detail is secured in articles formed by this technique.

WELDING

Many thermoplastic materials may be welded using a technique that is an adaptation of the metals' art with appropriate modifications. Suitable heat guns which will deliver hot gases at temperatures as high as 700 deg. F. at pressures of 5-40 psi. in the absence of flame are available commercially in this country.

The thermoplastic welding process was first employed successfully by Reinhardt using Saran and similar techniques were subsequently employed in Germany by Henning, who used more readily workable polyvinyl chloride. Suitable techniques for the welding of polymethyl methacrylate and polyethylene were developed in Germany and in Great Britain respectively at least 10 years ago.

Plastic welding rod is usually an extruded spline of the same material to be joined although sometimes it is advantageous to extrude a plasticized product for easy fabrication. The pieces to be welded should have their edges beveled at a 50-70 deg. angle. The spline should be slightly larger than the chamfer formed by the parts to be welded for polyethylene and slightly smaller for more rigid materials which do not have such a sharp melting point. The temperature of the gun is governed by the material to be welded and must be hot enough to secure a strong weld, yet must not cause excessive decomposition of the plastic material.

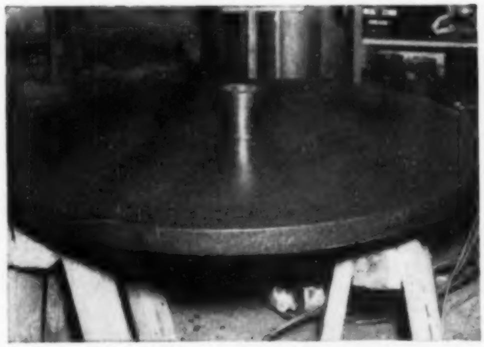
In the welding process, the spline is inserted with positive pressure perpendicularly to the chamfer, warmed to the recommended softening temperature by directing the gun at an angle of approximately 30 deg. to the sheet using a slight brushing action. As the spline or welding rod softens, the gun is moved progressively forward always keeping the spline and sheet in the same relative position. A properly formed plastic weld should have a strength of 80-90 percent of the non-welded sheet. A simple analysis of the growth of the metal welding industry will indicate the potential for plastics that has been made possible by the perfection of practical welding techniques for the fabrication of thermoplastics.

The basic techniques used in the welding process have been used to fabricate pipe, duct work, tanks and valves. These same materials may be extruded in the form of pipe, rod and structural members. Sheets, rod or other shapes of polymethyl methacrylate may be formed by polymerization of the corresponding monomer as well as by molding or extrusion. Regardless of the form of the plastic material, most thermoplastics can be machined using ordinary woodworking machinery.

Because of inavailability and a dearth of knowledge on physical and chemical properties, the use of fabricated plastics in America has been much less extensive than on the continent. However, American-made materials are now available and considerable know-how has been developed. As reliable application data become available, American industry will give considerably more attention to the plastic approach and adopt plastic structures when an intelligent study of the physical and chemical requirements indicate that a properly selected thermosetting plastic or thermoplastic will do the job.

Processing Equipment

Physical properties and resistance to chemicals determine usability of plastics for processing equipment. These tables will help you pick the right one.



CARBON-FILLED PHENOLIC disk made by casting.

Thermosetting Plastics

Chemical Resistance:

Legend:
+ = Satisfactory
− = Not recommended
C = Use with caution

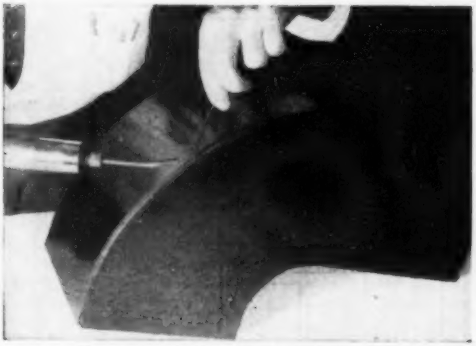
CORROSIVE (Deg. F. →)	Filled Phenolic 70	Filled Phenolic 225	Filled Polyfurfuryl Alcohol 70	Filled Polyfurfuryl Alcohol 225
Acetaldehyde	+	+	+	+
Acetic acid	+	+	+	+
Acetic anhydride	+	+	−	−
Acetone	+	+	+	+
Alcohol, ethyl	+	+	+	+
Allyl chloride	+	+	+	+
Alum	+	+	+	+
Aluminum chloride	+	+	+	+
Aluminum fluoride	+	+	+	+
Aluminum sulphate	+	+	+	+
Ammonia	−	−	+	+
Ammonium chloride	+	+	+	+
Ammonium metaphosphate	+	+	+	+
Ammonium nitrate	+	+	+	+
Ammonium persulphate	+	+	+	+
Ammonium sulphate	+	+	+	+
Ammonium thiocyanate	+	+	+	+
Amyl acetate	+	+	+	+
Amyl chloride	+	+	+	+
Aniline	+	+	+	+
Antimony trichloride	+	+	+	+
Aqua regia	−	−	−	−
Barium carbonate	+	+	+	+
Barium chloride	+	+	+	+
Barium hydroxide	+	−	+	+
Barium sulphate	+	+	+	+
Barium sulphide	+	−	+	+
Benzaldehyde	+	+	+	+
Benzene	+	+	+	+
Benzoic acid	+	+	+	+
Bismuth carbonate	+	+	+	+
Boric acid	+	+	+	+
Bromine, liquid	−	−	−	−
Bromine, water	+	−	−	−
Butyl acetate	+	+	+	+
Butyric acid	+	+	+	+
Calcium carbonate	+	+	+	+
Calcium chlorate	+	+	+	+
Calcium chloride	+	+	+	+
Calcium hydroxide	+	C	+	+
Calcium hypochlorite	+	C	+	+
Calcium sulphate	+	+	+	+
Camphor	+	+	+	+
Carbonic acid	+	+	+	+
Carbon bisulphide	+	+	+	+
Carbon monoxide	+	+	+	+
Carbon tetrachloride	+	+	+	+
Chloracetic acid	+	+	+	+
Chlorine gas	+	C	−	−
Chlorobenzene	+	+	+	+
Chloroform	+	+	+	+
Chromic acid, 5%	+	−	+	−
Citric acid	+	+	+	+
Copper chloride	+	+	+	+
Copper cyanide	+	+	+	+
Copper nitrate	+	+	+	+
Copper sulphate	+	+	+	+
Creosote	+	+	+	+
Cresylic acids	+	+	+	+
Carbon dioxide	+	+	+	+
Ether	+	+	+	+
Ethyl acetate	+	+	+	+
Ethyl chloride	+	+	+	+
Ethylene chlorhydrin	+	+	+	+
Ethylene dichloride	+	+	+	+
Ethylene glycol	+	+	+	+
Fatty acids	+	+	+	+
Ferric chloride	+	+	+	+
Ferric nitrate	+	+	+	+
Ferric sulphate	+	+	+	+
Ferrous chloride	+	+	+	+
Ferrous sulphate	+	+	+	+
Fluosilicic acid	+	+	+	+
Formaldehyde	+	+	+	+
Formic acid	+	+	+	+
Furfural	−	−	+	+
Hydrobromic acid	+	+	+	+
Hydrochloric acid	+	+	+	+
Hydrocyanic acid	+	+	+	+
Hydrofluoric acid	C	C	C	C
Hydrogen	+	+	+	+
Hydrogen bromide	+	+	+	+
Hydrogen chloride	+	+	+	+
Hydrogen sulphide	+	+	+	+
Hypochlorous acid	+	C	−	−
Iodine	−	−	−	−
Lactic acid	+	+	+	+
Lead acetate	+	+	+	+
Linseed oil	+	+	+	+
Magnesium carbonate	+	+	+	+
Magnesium chloride	+	+	+	+
Magnesium hydroxide	−	−	+	+
Magnesium nitrate	+	+	+	+
Magnesium sulphate	+	+	+	+
Maleic acid	+	+	+	+
Mercuric chloride	+	+	+	+
Mercuric cyanide	+	+	+	+
Mercurous nitrate	+	+	+	+
Mercury	+	+	+	+
Methyl chloride	+	+	+	+
Methyl ethyl ketone	+	+	+	+
Methyl sulphuric acid	+	+	+	+
Mixed acids	−	−	−	−
Naphtha	+	+	+	+
Naphthalene	+	+	+	+
Naphthenic acid	+	+	+	+
Nickel chloride	+	+	+	+
Nickel nitrate	+	+	+	+
Nickel sulphate	+	+	+	+
Nitric acid, 5%	+	−	C	−
Nitrobenzene	+	+	+	+
Nitriding gases	−	−	+	+
Oleic acid	+	+	+	+
Oxalic acid	+	+	+	+
Perchloric acid	+	C	+	C
Phenol	+	+	+	+
Phosphoric acid	+	+	+	+
Phthalic anhydride	+	+	+	+
Picric acid (in alcohol)	+	+	+	+
Potassium bicarbonate	+	+	+	+
Potassium bromide	+	+	+	+
Potassium carbonate	+	−	+	+
Potassium chlorate	+	+	+	+
Potassium chloride	+	+	+	+
Potassium dichromate	+	+	+	+
Potassium ferrocyanide	+	+	+	+
Potassium hydroxide	−	−	+	+
Potassium nitrate	+	+	+	+
Potassium permanganate	+	+	+	+
Potassium sulphate	+	+	+	+
Propylene dichloride	+	+	+	+
Silver nitrate	+	+	+	+
Sodium acetate	+	+	+	+
Sodium bicarbonate	+	+	+	+
Sodium bisulphate	+	+	+	+
Sodium bisulphite	+	+	+	+
Sodium bromide	+	+	+	+
Sodium carbonate	+	−	+	+
Sodium chlorate	+	+	+	+
Sodium chloride	+	+	+	+
Sodium cyanide	+	+	+	+
Sodium ferricyanide	+	+	+	+
Sodium fluoride	+	+	+	+
Sodium hydroxide	−	−	+	+
Sodium hypochlorite, 3%	+	−	+	−
Sodium nitrate	+	+	+	+
Sodium nitrite	+	+	+	+
Sodium sulphate	+	+	+	+
Sodium sulphide	−	−	+	+
Sodium sulphite	+	+	+	+
Stannic chloride	+	+	+	+
Stannous chloride	+	+	+	+
Stearic acid	+	+	+	+
Sulphur	+	+	+	+
Sulphur chloride	−	−	−	−
Sulphur dioxide	+	+	+	+
Sulphur trioxide	+	+	+	+
Sulphuric acid, 50%	+	+	+	+
Sulphuric acid, 80%	+	−	−	−
Sulphurous acid	+	+	+	+
Tannic acid	+	+	+	+
Tartaric acid	+	+	+	+
Trichloroethylene	+	+	+	+
Trisodium phosphate	+	−	+	+
Zinc chloride	+	+	+	+
Zinc sulphate	+	+	+	+

Physical Properties

Thermosetting Plastic Pipe

Property	Asbestos-Filled	Glass Fabric Reinforced 1 Layer	Glass Fabric Reinforced 4 Layers
Tensile strength, psi	3,000	1,800	2,200
Compressive strength, psi	10,000	10,000	5,000
Bursting strength, psi	500	160	300
Crushing strength, lb./ft	5,800	1,500	3,000
Impact resistance, in	54	30	78
Coefficient of expansion, per °C	2×10^{-6}	2×10^{-6}	2×10^{-6}
Thickness of pipe, in	0.65	0.25	0.5
Weight, lb./ft	4	2.5	4

Note: All values were secured using 4 in. pipe. Impact data were obtained by measuring the height required to crack the pipe when a 4 lb. steel ball was dropped vertically.



POLYVINYL CHLORIDE duct being welded.

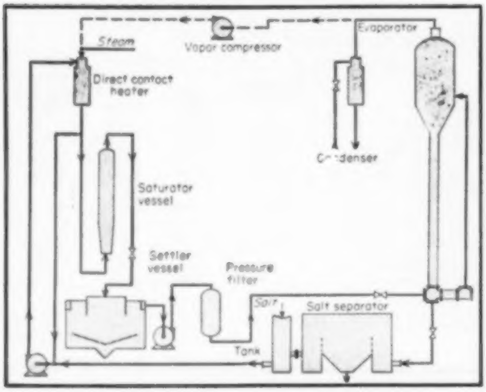
Physical Properties

Property	Polymethyl Methacrylate	Polyethylene	Saran	Polyvinyl Chloride
Maximum useful temp., ° F.	130	120	160	160
Welding temp.	525–45	240–60	350–400	440–85
Tensile strength, psi	8,000	2,500	5,000	9,000
Compressive strength, psi	12,000	......	8,000	10,000
Modulus of elasticity, psi	4×10^5	2×10^5	1×10^5	2×10^5
Flexural strength, psi	12,000	1,700	16,000	16,000
Coefficient of expansion, per °C	8×10^{-5}	4×10^{-4}	16×10^{-5}	8×10^{-5}
Thermal conductivity, cal./cm./sec./° C./cm.²	4×10^{-4}	8×10^{-4}	3×10^{-4}	4×10^{-4}
Specific heat, cal./g./° C	0.35	0.55	0.32	0.24
Specific gravity	1.2	0.9	1.7	1.4
Specific volume, cu. in./lb.	23	30	16	18
Rockwell hardness	M-93	R-11	M-60	M-60
Dielectric constant, 10^6 cycles	3	2.3	4	3
Water absorption, %	0.3	0.01	0.5	0.5
Flammability	Slow	Slow	Self Extinguish	Self Extinguish

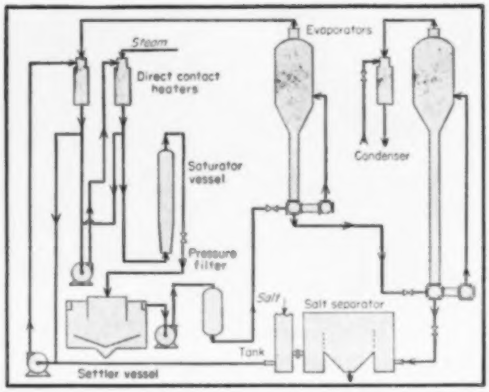
Thermoplastics

Chemical Resistance:

CORROSIVE	Polymethyl Methacrylate		Polyethylene		Saran		Polyvinyl Chloride	
Deg F.→	70	150	70	150	70	150	70	150
Acetaldehyde	−	−	+	−	−	−	−	−
Acetic acid, 10%	+	+	+	+	+	C	+	C
Acetic, glacial	−	−	−	−	−	−	+	−
Acetic anhydride	−	−	−	−	−	−	−	−
Acetone	−	−	C	−	−	−	−	−
Alcohol, ethyl	+	+	+	+	+	+	+	+
Allyl chloride	−	−	−	−	−	−	−	−
Alum	+	+	+	+	+	+	+	+
Aluminum chloride	+	+	+	+	+	+	+	+
Aluminum fluoride	+	+	+	+	+	+	+	+
Aluminum sulphate	+	+	+	+	+	+	+	+
Ammonia	+	+	+	+	C	−	+	+
Ammonium chloride	+	+	+	+	+	+	+	+
Ammonium metaphosphate	+	+	+	+	+	+	+	+
Ammonium nitrate	+	+	+	+	+	+	+	+
Ammonium persulphate	+	+	+	+	+	+	+	+
Ammonium sulphate	+	+	+	+	+	+	+	+
Ammonium thiocyanate	+	+	+	+	+	+	+	+
Amyl acetate	−	−	−	−	−	−	−	−
Amyl chloride	−	−	−	−	−	−	−	−
Aniline	−	−	−	−	−	−	−	−
Antimony trichloride	+	+	+	+	+	+	+	+
Aqua regia	−	−	−	−	−	−	−	−
Barium carbonate	+	+	+	+	+	+	+	+
Barium chloride	+	+	+	+	+	+	+	+
Barium hydroxide	+	+	+	+	+	+	+	+
Barium sulphate	+	+	+	+	+	+	+	+
Barium sulphide	+	+	+	+	+	+	+	+
Benzaldehyde	−	−	−	−	−	−	−	−
Benzene	−	−	−	−	−	−	−	−
Benzoic acid	+	+	+	+	+	+	+	+
Bismuth carbonate	+	+	+	+	+	+	+	+
Boric acid	+	+	+	+	+	+	+	+
Bromine, water	C	−	−	−	C	−	+	+
Bromine, liquid	−	−	−	−	−	−	−	−
Butyl acetate	−	−	−	−	−	−	−	−
Butyric acid	−	−	−	−	−	−	−	−
Calcium carbonate	+	+	+	+	+	+	+	+
Calcium chlorate	+	+	+	+	+	+	+	+
Calcium chloride	+	+	+	+	+	+	+	+
Calcium hydroxide	+	+	+	+	+	+	+	+
Calcium hypochlorite	+	+	+	−	+	+	+	+
Calcium sulphate	+	+	+	+	+	+	+	+
Carbonic acid	+	+	+	+	+	+	+	+
Carbon bisulphide	−	−	−	−	−	−	−	−
Carbon monoxide	+	+	+	+	+	+	+	+
Carbon tetrachloride	−	−	−	−	−	−	−	−
Chloracetic acid	−	−	+	+	+	+	+	+
Chlorine gas	−	−	−	−	+	+	+	+
Chlorobenzene	−	−	−	−	−	−	−	−
Chloroform	−	−	−	−	−	−	−	−
Chromic acid, 25%	−	−	+	+	+	+	+	+
Citric acid	+	+	+	+	+	+	+	+
Copper chloride	+	+	+	+	+	+	+	+
Copper cyanide	+	+	+	+	+	+	+	+
Copper nitrate	+	+	+	+	+	+	+	+
Copper sulphate	+	+	+	+	+	+	+	+
Cresylic acids, 50%	−	−	+	+	+	+	+	+
Carbon dioxide	+	+	+	+	+	+	+	+
Ether	−	−	−	−	−	−	−	−
Ethyl acetate	−	−	−	−	−	−	−	−
Ethyl chloride	−	−	−	−	−	−	−	−
Ethylene chlorhydrin	−	−	−	−	−	−	−	−
Ethylene dichloride	−	−	−	−	−	−	−	−
Ethylene glycol	+	+	+	+	+	+	+	+
Ferric chloride	+	+	+	+	+	+	+	+
Ferric nitrate	+	+	+	+	+	+	+	+
Ferric sulphate	+	+	+	+	+	+	+	+
Ferrous chloride	+	+	+	+	+	+	+	+
Ferrous sulphate	+	+	+	+	+	+	+	+
Fluorine	−	−	−	−	−	−	+	C
Fluosilicic acid	+	+	+	+	+	+	+	+
Formaldehyde	−	−	+	+	+	+	+	+
Formic acid	+	+	+	+	+	+	+	C
Furfural	−	−	−	−	−	−	−	−
Hydrobromic acid	+	+	+	+	+	+	+	+
Hydrochloric acid	+	+	+	+	+	+	+	+
Hydrocyanic acid	+	+	+	+	+	+	+	+
Hydrofluoric acid	+	+	+	+	+	+	+	+
Hydrogen peroxide	−	−	+	+	+	+	+	+
Hydrogen sulphide	+	+	+	+	+	+	+	+
Hypochlorous acid	+	+	−	−	+	+	+	+
Iodine	−	−	−	−	−	−	−	−
Lactic acid	+	C	+	+	+	+	+	+
Lead acetate	+	+	+	+	+	+	+	+
Linseed oil	+	−	−	−	+	+	+	+
Magnesium carbonate	+	+	+	+	+	+	+	+
Magnesium chloride	+	+	+	+	+	+	+	+
Magnesium hydroxide	+	+	+	+	+	+	+	+
Magnesium nitrate	+	+	+	+	+	+	+	+
Magnesium sulphate	+	+	+	+	+	+	+	+
Mercuric chloride	+	+	+	+	+	+	+	+
Mercuric cyanide	+	+	+	+	+	+	+	+
Mercurous nitrate	+	+	+	+	+	+	+	+
Mercury	+	+	+	+	+	+	+	+
Methyl chloride	−	−	−	−	−	−	−	−
Methyl ethyl ketone	−	−	−	−	−	−	−	−
Methyl sulphuric acid	−	−	+	+	+	+	+	+
Mixed acids	−	−	+	+	+	+	+	+
Naphtha	−	−	+	−	+	+	+	+
Naphthalene	−	−	−	−	C	−	−	−
Nickel chloride	+	+	+	+	+	+	+	+
Nickel nitrate	+	+	+	+	+	+	+	+
Nickel sulphate	+	+	+	+	+	+	+	+
Nitric acid, 50%	−	−	+	+	+	C	+	+
Nitric acid vapors	C	−	+	+	+	+	+	+
Nitrobenzene	−	−	−	−	−	−	−	−
Nitriding gases	+	+	+	+	C	−	+	+
Oleic acid	+	−	−	−	+	+	+	+
Oxalic acid	+	+	+	+	+	+	+	+
Oxidizing gases	C	−	+	+	+	+	+	+
Perchloric acid	+	−	+	+	+	+	+	+
Phenol	−	−	−	−	−	−	+	C
Phosphoric acid	+	+	+	+	+	+	+	+
Picric acid (in alcohol)	−	−	−	−	−	−	−	−
Potassium bicarbonate	+	+	+	+	+	+	+	+
Potassium bromide	+	+	+	+	+	+	+	+
Potassium carbonate	+	+	+	+	+	C	+	+
Potassium chlorate	+	+	+	+	+	+	+	+
Potassium chloride	+	+	+	+	+	+	+	+
Potassium dichromate	+	+	+	+	+	+	+	+
Potassium ferri- or ferrocyanide	+	+	+	+	+	+	+	+
Potassium hydroxide	+	+	+	+	C	−	+	+
Potassium nitrate	+	+	+	+	+	+	+	+
Potassium permanganate 10%	+	+	+	−	+	+	+	+
Potassium sulphate	+	+	+	+	+	+	+	+
Propylene dichloride	−	−	−	−	−	−	−	−
Silver nitrate	+	+	+	+	+	C	+	C
Sodium acetate	+	+	+	+	+	+	+	+
Sodium bicarbonate	+	+	+	+	+	+	+	+
Sodium bisulphate	+	+	+	+	+	+	+	+
Sodium bisulphite	+	+	+	+	+	+	+	+
Sodium bromide	+	+	+	+	+	+	+	+
Sodium carbonate	+	+	+	+	+	C	+	+
Sodium chlorate	+	+	+	+	+	+	+	+
Sodium chloride	+	+	+	+	+	+	+	+
Sodium cyanide	+	+	+	+	+	+	+	+
Sodium ferri- or ferrocyanide	+	+	+	+	+	+	+	+
Sodium fluoride	+	+	+	+	+	+	+	+
Sodium hydroxide	+	+	+	+	C	−	+	+
Sodium hypochlorite	+	−	+	−	+	C	+	+
Sodium nitrate	+	+	+	+	+	+	+	+
Sodium nitrite	+	+	+	+	+	+	+	+
Sodium sulphate	+	+	+	+	+	+	+	+
Sodium sulphide	+	+	+	+	+	C	+	+
Sodium sulphite	+	+	+	+	+	+	+	+
Stannic chloride	+	+	+	+	+	+	+	+
Stannous chloride	+	+	+	+	+	+	+	+
Stearic acid	+	+	−	−	+	+	+	+
Sulphur	+	+	+	+	+	+	+	+
Sulphur dioxide	+	+	+	+	+	+	+	+
Sulphur trioxide	+	+	+	+	+	+	+	+
Sulphuric acid, 80%	−	−	+	+	+	+	+	+
Sulphuric acid, 96%	−	−	+	−	C	−	+	C
Sulphurous acid	+	+	+	+	+	+	+	+
Tannic acid	+	+	+	+	+	+	+	+
Tartaric acid	+	+	+	+	+	+	+	+
Trichloroethylene	−	−	−	−	−	−	−	−
Trisodium phosphate	+	+	+	+	+	+	+	+
Zinc chloride	+	+	+	+	+	+	+	+
Zinc sulphate	+	+	+	+	+	+	+	+



SINGLE EFFECT process designed for rock or sea salt.



DOUBLE EFFECT process was worked out in the pilot plant.

New Salt Process Omits Usual Problems

In the separation and refining of rock salt and other mixed salts, power cost is low, product control is high, scaling problems are eliminated. Installed cost of a refining unit is about 60 percent of usual equipment.

R. B. RICHARDS

Present salt refining equipment leaves much to be desired. For years, standard equipment has consisted of calandria-type vacuum pans operating in multiple effect, or multiple-effect crystallizers using forced circulation outside closed heaters.

Everyone in the industry has been aware of the disadvantages of process and equipment: (1) scaling of tubular heating surfaces; (2) concentration of unwanted soluble and insoluble salts in the evaporators, the latter often acting as nuclei for irregular crystal formation; (3) necessity for close control of the chemical treatment which removes calcium and magnesium salts from the solution of crude salt (in order to prevent high concentration of treating chemicals in the evaporator liquor and to prevent undesirable salt precipitation); and (4) high cost of evaporator equipment and high cost of steam production. (Refining takes 2,000 lb. of steam per ton of sodium chloride in quadruple effect units or 2,600 lb. in triple effect.)

To eliminate most of these undesirable features of present practice, a new process* has been developed by the International Salt Co., Inc. No tubular heating surfaces or salt dissolution tanks are used; concentrations of undesirable salts in the evaporator bodies are avoided; and the steam cost of refining is reduced. A 25 ton per day pilot plant has been successfully operated for some time at Watkins Glen, N. Y.

R. B. Richards *is chief engineer of the New York State Evaporating Plants of the International Salt Co., Inc.*

HOW IT WORKS

Solid salt is fed to the unit by the salt feeder which discharges salt into a small tank through which a continuously circulating flow of saturated brine is also passing (see flowsheet). This maximum of crude salt and brine is immediately pumped to a direct contact heater where it is heated by steam. The temperature to which the brine and salt are heated is controlled by regulating the amount of steam fed to the heater; the steam is condensed, thus diluting the brine. Salt in suspension begins to dissolve immediately. The heated brine and salt flows to the saturator vessel of upflow design and of sufficient volume and retention period so that the heated brine approaches saturation in it. The rate at which the salt is fed to the feed tank controls the amount of crude salt in suspension in the vessel. This in turn controls the saturation of the brine leaving the saturator vessel. If the heater is operated at atmospheric pressure and sufficient steam is supplied, the temperature of the brine leaving the saturator will be slightly less than the normal boiling temperature of a saturated solution of the salt feed, (225 deg. F.). A small amount of fine salt and all insolubles will be carried out of this saturator with the brine, which then flows to a settler vessel. In this settler all relatively coarse insolubles settle out, while the brine overflows and is pumped through a pressure filter where the remaining insolubles are filtered out.

EFFICIENT HEAT EXCHANGE

The clarified hot saturated brine then is circulated to the evaporator leg, where it is mixed with the brine circulating in the evaporator or crystallizer body. The temperature of the brine circulating in the crystallizer is maintained at a predetermined temperature by a condenser. The hot feed brine, when it mixes with the internally circulating brine, will flash cool in the body of the crystallizer and liberate vapor while cooling. The amount of vapor released will be about the same as that used in the original heating, and the salt crystallizing out during

* U. S. Pat. 2,555,340. All information in this article covered by patents issued and pending.

the cooling process will be about the same as that dissolved in passing through the saturator vessel.

A slurry of crystallized salt and brine is discharged from the evaporator through a level control valve and passed to the salt separator where the salt settles out. The clear brine overflows to the salt feed tank where it picks up more salt. Thus the process is continuous, the refined salt settling out and additional crude salt being fed at the desired production rate.

The refined salt settling out in the salt separator can be pumped as a slurry to a centrifuge or top feed filter which separates the salt from the brine. The brine is then returned to the salt separator vessel.

When it is necessary to treat the brines chemically to remove undesirable soluble salts from the system, the necessary chemicals, such as caustic, can be added with the salt, and the precipitated salts will be removed in the settler and filters.

Where electric power is sufficiently low in cost or boiler steam is not available, the vapor compression cycle can be used in place of boiler steam. The use of a diesel driven vapor compressor in this process is very practical. Since the absence of tubular heating surface permits the compressor to operate under conditions of maximum heat utilization, the over-all thermal efficiency of such a refining unit would be at least 70 percent. When closed tubular heaters are used, the range of compression must be great enough to raise the saturated temperature of the compressed vapor high enough to offset the temperature drop across the tubes of the heater plus the "boiling point rise of the saturated solution."

LOW POWER COST

In this new process this loss of effective temperature level is avoided because the vapor condensing in the brine raises the temperature of that brine to the boiling point corresponding to the vapor pressure existing in the heater. For example, assuming that the pressure of the vapor discharged from the compressor is atmospheric, the saturated temperature would be 212 deg F., the brine discharging from the heater would then be approximately 225 deg. F., and the heater would operate at atmospheric pressure. Thus, in this process, the power cost of overcoming the boiling point rise is eliminated. The difference in pressure between the inlet and outlet of the vapor compressor will determine the temperature difference between the heater and the evaporator. To make the operation of the unit self-sustaining, this pressure difference should be about 12 psi. Even so, the power cost of operating the unit is astonishingly low.

DOUBLE EFFECT MORE EFFICIENT

Greater production rates per unit of flow through the heater and filters as well as better steam economy are obtained by additional effects, such as the double effect unit shown.

In the double effect unit the mixture of salt and brine discharged from the crystallizer, instead of passing to the salt separator, is passed to the second stage flash crystallizer. The temperature of the brine in this second crystallizer is maintained at a much lower temperature than that existing in the first evaporator. The brine is flash cooled to this lower temperature, depositing additional salt and releasing additional vapor. The mixture of salt and brine from the second evaporator is passed to the salt separator vessel where the refined salt is settled out and the brine is passed to the salt feeder tank as before.

For the purpose of economy the vapor released in the first crystallizer is condensed in the second heater which is supplied with the relatively cool brine and salt from the salt feeder tank. The use of this second stage of flash cooling and reheating will reduce the steam consumption per ton of salt produced by approximately 40 percent.

The quality of salt produced by flashing to this lower temperature is not affected, but the production of salt per gallon of brine circulating through the equipment is materially increased. A third stage of flash cooling and reheating can be added for further economy.

The new process, when used to refine sodium chloride, takes advantage of the fact that calcium sulphate becomes decreasingly soluble in sodium chloride solutions as the temperature is raised above 180 deg. If the high temperature direct contact heater is operated at atmospheric pressure, the temperature of the brine leaving the heating zone would be about 225 deg. F., and it is at this temperature that the dissolution of the rock salt takes place. The dissolution of the gypsum also takes place and the brine leaving the filters is saturated with calcium sulphate as well as with sodium chloride. However, the amount of calcium sulphate in solution will be much less, at 225 deg., than would be present at a temperature of 180 deg. F. or less. Consequently, when the brine is flash cooled after the settling and filtering operation, this cooled brine is considerably undersaturated with calcium sulphate, and calcium sulphate cannot crystallize in the evaporator so the sodium chloride produced is relatively free of this impurity.

HIGH GRADE OF PURITY

Salt refined by this process is almost calcium sulphate free; a small amount of brine in the crystal and inadequate washing of the mother liquor from the crystal surfaces in the centrifuge or filter will result in a final calcium sulphate that will not exceed 0.004 percent calcium sulphate.

When New York State rock salt is fed into the pilot unit and sufficient caustic is used to maintain the circulating brines at a pH of approximately 10.8, the cool circulating brines have the following analysis:

$CaSO_4$	—	2.53 gpl.
$CaCl_2$	—	0.76 "
NaOH	—	0.16 "
$MgCl_2$	—	0.001 "
NaCl	—	saturated

Salt produced from this brine will average the following analysis without excess washing:

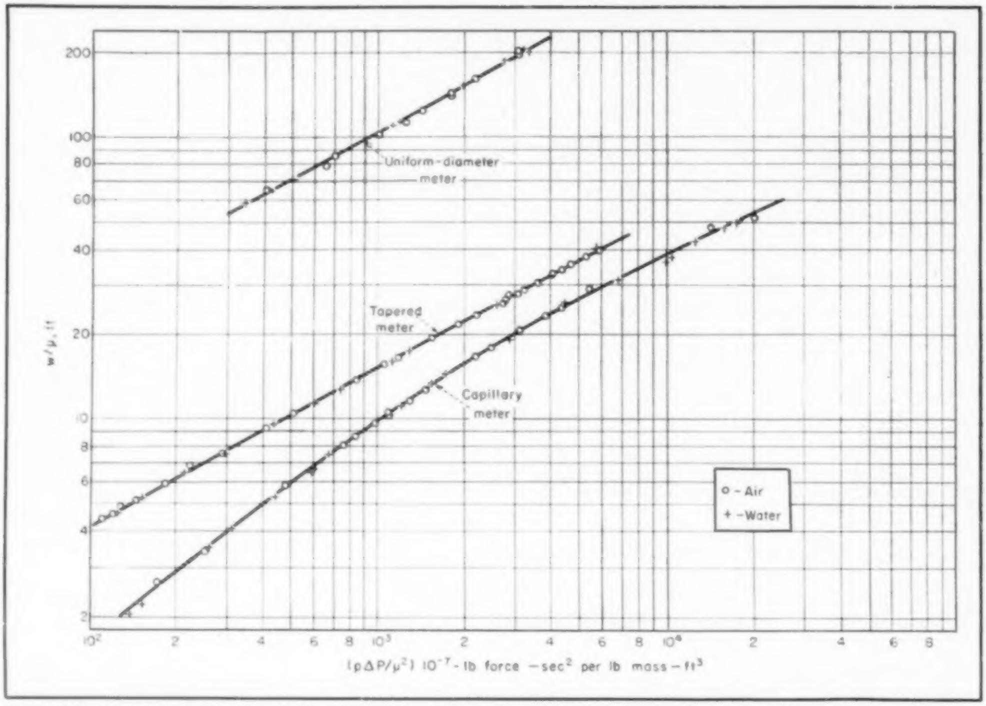
Moisture	—	0.020 percent
$CaSO_4$	—	0.005 "
$CaCl_2$	—	0.002 "
$MgCl_2$	—	0.001 "
Fe_2O_3	—	0.0000 "
NaCl (Dry)	—	99.992 "

The above salt centrifuged, and reslurried with brine (made up by dissolving the above salt) and centrifuged a second time will have the following analysis:

Moisture	—	0.020 percent
$CaSO_4$	—	0.001 "
$CaCl_2$	—	0.0005 "
$MgCl_2$	—	0.0002 "
Fe_2O_3	—	0.0000 "
NaCl (Dry)	—	99.998 "

The advantage of this process with respect to control over the purity of the product is apparent. The continuous recirculation of the evaporator brines through the settler and filter prevents the accumulation of the precipitated insoluble salts in the concentrated evaporator brines which occurs in the conventional process. Any excess chemicals required in the chemical treatment of the brine are not concentrated in the evaporator brines, but are returned to the treating system.

The absence of heating surfaces has eliminated scale problems, which are frequent in the conventional process. In addition, the absence of heating surfaces permits the selection of the proper crystallizer temperature whereby it is practical to make a separation of soluble salts such as crude mixture of KCl—NaCl etc. In this case the salt most insoluble at the high temperature would be settled out, while the more soluble salt would be crystal-



EXPERIMENTAL PROOF: Two fluids with widely differing densities and viscosities demonstrate the same flow rates.

Convenient Flowmeter Conversions

This article demonstrates the feasibility of calibrating any flowmeter with the most convenient fluid at hand (e.g., air or water) and of converting the calibration so obtained to any other fluid without loss of accuracy.

DAVID P. HERRON

Flow rates are often measured by observing the loss in static pressure of a fluid when it passes through a constriction in the line. In orifices and venturi meters the pressure loss is caused primarily by an increase in the kinetic energy of the fluid flowing. In the common type of glass flowmeter, often used for laboratory work, the downstream pressure tap is usually far from the restricted section, the kinetic energy increase is small, and the pressure loss is mainly due to fluid friction.

D. P. Herron *carried out this work while a member of the staff of the School of Chemical Engineering Practice, Massachusetts Institute of Technology. He is now with the Atlantic Research Corp., Alexandria, Va.*

It is often necessary for the engineer to calibrate differential-pressure flowmeters and to correct the original calibrations for deviations of density and viscosity from the calibrating conditions. There are standard procedures for making such corrections for orifices and venturi meters. (To wit: by using the appropriate coefficient, C, in the familiar flowmeter equation. C is determined as a function of the Reynolds number either by direct calibration or from readily available tables published for standard orifice and venturi meter installations.)

No single relation correcting for changes in Reynolds number, applicable to all types of differential-pressure flowmeters, is in common use. Benton[1] and Whitwell[8] discuss the effects of density and viscosity on flow through glass laboratory flowmeters and recommend the use of several relations, depending upon the shape of the meter and upon whether the flow is streamline or turbulent.

The purpose of this article is to derive a single relation suitable for all types of differential-pressure flowmeters in both the streamline and turbulent regions. Supporting data show that this relation holds even for relatively great differences in the densities and viscosities of the fluids flowing.

FLOW RELATIONS

In the following derivation, it is assumed that there are no potential energy changes and that between the two pressure taps variations in density and viscosity are negligible. Then Bernoulli's equation may be written:

$$-\Delta P/\rho = (1/g_c)(V_2^2/\alpha_2 - V_1^2/\alpha_1) + \Sigma F \quad (1)$$

Expressions for the various friction losses which make up F are given by Perry.[3] All of these expressions—the Fanning equation, empirical relations for elbows, sudden contractions or expansions, gradual contractions, uniform diameter sections, etc., in both streamline and turbulent flow—can be reduced to an equation of the form:

$$F = (w^2/\rho^2)\,\phi_1(w/\mu) \quad (2)$$

The function $\phi_1(w/\mu)$, of course, includes various tube dimensions, which are constant for any one flowmeter.

Eq. (1) can be rewritten:

$$-\frac{\Delta P}{\rho} = \frac{1}{g_c}\left[\frac{w^2}{\rho^2\,\phi_2(w/\mu)} - \frac{w^2}{\rho^2\,\phi_3(w/\mu)}\right] + \Sigma(w^2/\rho^2)\phi_4(w/\mu) \quad (3)$$

where the functions ϕ_2 and ϕ_3 include linear dimensions of the flowmeter. This equation can be rewritten:

$$-\rho\,\Delta P/w^2 = \phi_5(w/\mu) \quad (4)$$

Eq. (4) should apply at various densities and viscosities to any one flowmeter. As would be expected, the orifice equation can be reduced to this same form. The equation for orifices may be written[4] as follows:

$$q = \frac{S_o\,(2g_c\,\Delta P/\rho)^{1/2}}{(1-\beta^4)^{1/2}}\,\phi_6(4w/\pi\,\mu\,D_o) \quad (5)$$

Here the orifice coefficient, C, has been expressed as a function of the Reynolds number, $4w/\pi\mu D_o$.

By including all meter dimensions and other constants in a new function of w/μ, Eq. (5) becomes:

$$q = [(\Delta P/\rho)\,\phi_7(w/\mu)]^{1/2} \quad (6)$$

which can readily be reduced to the same form as Eq. (4).

NOMENCLATURE

- **C = Orifice coefficient**
- **D_o = Orifice diameter**
- **g_c = Conversion factor to relate force units and mass units**
- **k = Constant for a given flowmeter**
- **ΔP = pressure drop across flowmeter**
- **q = Volume rate of flow**
- **S = Cross-sectional area of flow**
- **V = Average velocity at a cross-section**
- **w = Mass rate of flow**
- **α = Correction factor for velocity distribution at a cross-section**
- **β = Ratio of orifice diameter to pipe diameter**
- **μ = Absolute fluid viscosity**
- **ρ = Average fluid density**
- **ϕ = Prefix, indicating a function**

SUBSCRIPTS:

1, 2, 3, etc., refer to different functions or different cross sections. *o* refers to orifice opening.

Note: All quantities must be expressed in consistent units.

Eq. (4) is rather inconvenient to use, since trial-and-error is involved if the flow rate is to be found from a known pressure drop. Multiplying both sides by $(w/\mu)^2$ gives a more useful relation:

$$-\rho\,\Delta P/\mu^2 = \phi_8(w/\mu) \quad (7)$$

Eqs. (4) and (7) are essentially expressions of the principle of dynamic similarity, which states that flow characteristics of various fluids should be the same at a given Reynolds number.

The proposed relation, Eq. (7), can be reduced to simple forms in certain special cases. As Benton[1] showed, for streamline flow in long-tube capillary meters with negligible end effects, Eq. (7) becomes:

$$-\rho\,\Delta P/\mu^2 = k_1(w/\mu) \quad (8)$$

while including a term for end effects gives:

$$-\rho\,\Delta P/\mu^2 = k_2(w/\mu) + k_3(w/\mu)^2 \quad (9)$$

Also, for an orifice in which the Reynolds number is above 30,000, the orifice coefficient is practically constant,[4] and Eq. (7) becomes:

$$-\rho\,\Delta P/\mu^2 = k_4(w/\mu)^2 \quad (10)$$

or

$$w = (1/k_4)\,(\rho\,\Delta P)^{1/2} \quad (11)$$

PROOF

Applicability of Eq. (5), and hence of Eq. (7), to orifices and venturi meters over wide ranges of Reynolds numbers has been tested by many investigators; there is little doubt that Eq. (7) expresses the flow through such meters with satisfactory accuracy. Few results have been published, however, on the effects of wide variations in density and viscosity in glass laboratory flowmeters.

Three common types of these glass flowmeters—a uniform diameter glass tube, a capillary flowmeter, and a sharply tapered flowmeter made by drawing out a glass tube—were calibrated on water and air, fluids having greatly different densities and viscosities. All of the data were taken at room temperature and atmospheric pressure. Based on the smallest cross-section in each of the meters, Reynolds numbers ranged from 5,400 to 18,000 for the uniform diameter tube, 660 to 13,000 for the capillary flowmeter, and 1,200 to 12,200 for the tapered meter.

The graphical correlation of the data by this equation is seen to be quite satisfactory for all three flowmeters, as the data for both air and water lie consistently on the same curves.

Within the precision of the experimental technique used, it appears to be as accurate to calibrate any of the flowmeters on one fluid and use the calibration for calculating the flow of the second fluid as it would have been to calibrate the meter on the second fluid directly.

In practice Eq. (7) has been found useful in calibrating gas flowmeters used for experimental absorption towers when the desired gas rates have been above the capacity of the available calibrating devices or when dealing with water-soluble or corrosive gases, such as ammonia or hydrogen chloride. The calibration can be conveniently made with water even though the flowmeter is used for gas-flow measurement.

The flows of various liquids through spray nozzles have been correlated very satisfactorily by Eq. (7). This equation has also been used where it was inconvenient to insert a flowmeter of the usual type in the line. Here flow was measured by calibrating the pressure drop through a section of the line itself. A slightly modified form of Eq. (7) can also be applied at any given position of the float in a rotameter, as shown by Martin.[2]

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NEW SALT PROCESS

Continued from page 141

lized out in one or all of the crystallizers; the salts settled out can then be refined in a separate refining unit.

In this new process the steam used per ton of salt refined is considerably less than that of the conventional process, mainly because there is maximum utilization of the temperature drop available. Loss of effective temperature levels due to boiling point rise per effect; temperature losses across the tubes of the heater and losses of heat in the condensate drained from each effect are eliminated in this process. As a result, when sodium chloride is refined, the new process will require 1,900 lb. of steam per ton of refined salt in a double effect unit and 1,400 lb. of steam in a triple effect flash unit, as compared to 2,600 lb. of steam per ton of salt in conventional triple effect.

Since tubular heating units are not used, the installed cost of a refining unit based upon this process is only 60 percent of that of the conventional process equipment.

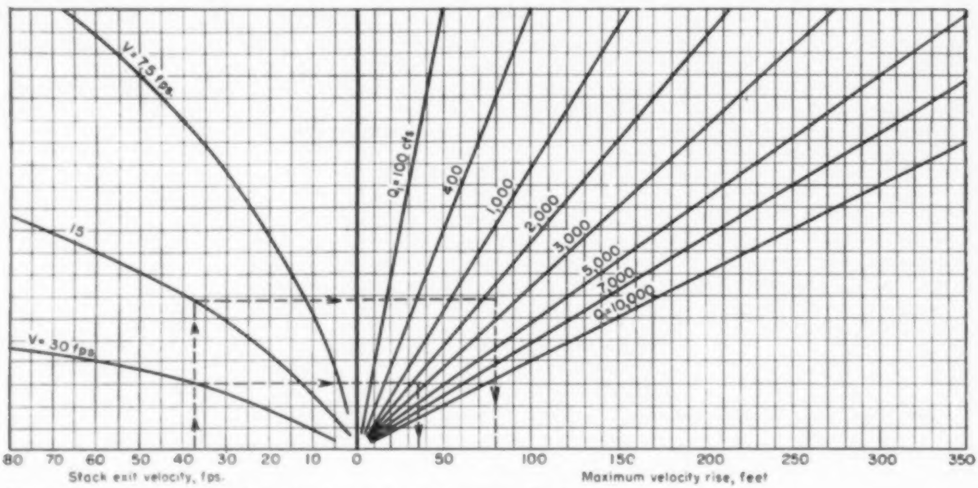

Fig. 1—Chart gives maximum velocity rise; for rise at any distance see Fig. 2.

Stacks for Pollution Control—II

Last month's article showed how stack height affects ground concentration and gave a rough method of calculation. This article adds the refinement of plume height. Next month, solid particles.

R. S. STEINBOCK

Effect of stack height on the dispersion of gaseous chimney discharges was discussed in Part I of this article (*Chem. Eng.*, Feb. 1952, p. 202). It is important to note that the maximum ground concentration of the pollutant varies inversely as the square of the effective stack height.

By "effective stack height" we mean the actual height of the chimney, plus the plume rise. If only an approximate calculation is required, the plume rise factor may be ignored and the actual stack height may be substituted in the formulas discussed in Part I of this article. Suppose, however, that to meet the requirements of maximum permissible concentration an effective stack height of 275 ft. is required.

If the plume rise is ignored this is the actual height of the chimney which will have to be built. But suppose that the plume rise is 50 ft. Then we have an effective height of 325 ft. and the concentration will be reduced in the ratio of $(275/325)^2$, i.e., the concentration will be only about 70 percent of the permitted value. From a pollution standpoint this is advantageous, but the investment could well have been reduced by making the stack only 225 ft. high, since the plume

R. S. Steinbock, in the engineering division of Imperial Oil Ltd. at Sarnia, Ont., is concerned mainly with the development of the company's utility services. He is the author of a number of technical papers including one on insulation thickness in our May 1950 issue.

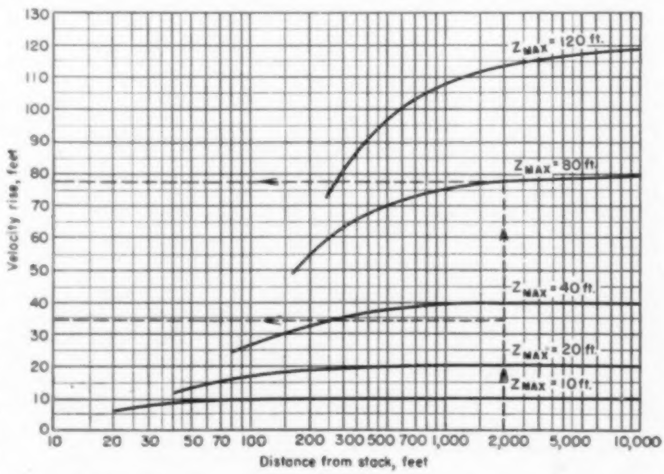

Fig. 2—Chart converts maximum to actual velocity rise at any distance.

rise would have yielded the necessary additional effective height for dispersion.

It is due to Bosanquet, Carey and Halton (*J. Inst. Mech. Engrs.*, London, Dec. 1950) that we now have a method for calculating the plume rise. With it substantial savings in stack investment can often be made.

PLUME RISE

How high a plume will rise depends on:

1. The velocity with which the gas is discharged from the stack.
2. The difference in density between the gas and the surrounding atmosphere due to the temperature difference between them.
3. The gradient of the potential atmospheric temperature.

The first two factors are self-explanatory and they will determine the path of a plume. The third factor, however, will determine the maximum height which the plume can attain. It requires some explanation.

The gradient of the potential atmospheric temperature is the deviation from adiabatic conditions. The atmosphere is said to be adiabatic when the temperature decreases with height at the rate of 2 deg. C. per 1,000 ft. rise. Departures from this rate of change are frequent and the gradient is the difference between the actual and adiabatic conditions. Thus, if the air temperature decreases at the rate of 1 deg. C. per 1,000 ft., the gradient of the potential atmospheric temperature = $(-1)-(-2)$ i.e. $=1$. Mathematically, if G = gradient of the potential atmospheric temperature and γ = actual rate of change in atmospheric temperature, then $G = \gamma + 2$.

When G is negative it follows that the air temperature decreases with height more rapidly than under adiabatic conditions. Under those circumstances the plume will continue to rise indefinitely. A much more common condition, however, is for the air temperature to decrease at a slower rate than under adiabatic conditions. Then G is positive and an equilibrium will be reached. The plume after attaining a maximum height will continue to travel horizontally.

So far we dealt only with a decreasing air temperature with height (i.e., negative γ). If the temperature increases with height (i.e., γ is positive) we have a case of "temperature inversion." (The equations and charts discussed below can be used for slight inversion where J in Eq. (5) remains positive. For more serious inversion, cleanup of the effluents is needed by means of separating equipment.—*Editor.*)

Steps in Calculating a Plume Rise Problem

Step	Use Fig.	Operation	At Wind Velocity V = 30 fps.	At Wind Velocity V = 15 fps.
1	—	Find $T_1 = (273 + 20)\delta = 293 \times 1.03$	302	302
2	—	Find $\Delta = T - T_1 = 450 - 302$	148	148
3	—	Find $\Delta/T_1 = 148/302$	0.49	0.49
4	1	Find maximum velocity rise	35	80
5	2	Find actual velocity rise at 2,000 ft. from stack	34.8	77.5
6	—	Find rise due to density difference alone, as follows:		
	3a	Find coefficient A	37.5	75
	3b	Find coefficient B	8.5	70
	3c	Find rise due to density diff	54	315
7	—	Add velocity rise (step 5) and rise due to density difference (step 6)	88.8*	392.5*
8	—	Calculate $T_1/\Delta = 302/148$	2.04	2.04
9	—	Find components of factor J, as follows:		
	4a	Find coefficient C	1.31	1.31
	4b	Find coefficient D	0.66	0.68
	4c	Find coefficient E	3.25	0.75
10	—	Calculate factor $J = E(C - D) + 1$	3.05	1.5
11	4d	Find factor P	2.25	0.81
12	—	Calculate $S = P + 2/J - 2$	0.91	0.15
13	4e	Find maximum rise due to density diff. and temperature gradient	7.6	10.5
14	—	Add velocity rise (step 5) and rise found in step 13	42.4	88
15	—	Compare results obtained in steps 7 and 14. Conclude that in this case the effect of the temperature gradient was to reduce the plume rise at a point 2,000 ft. from the stack. Hence use result of step 14 and not that of step 7.		

* This ignores the effect of the gradient of the potential atmospheric temperature and hence the check in steps 8 to 14 is needed.

CALCULATING PLUME RISE

Velocity Rise—The maximum height which a plume will attain due to velocity rise alone is given by the equation:

$$Z_{max.} = \frac{4.77}{1 + 0.43\, V/u} \times \frac{\sqrt{Q_1 u}}{V} \qquad (1)$$

and the height at a distance X from the stack is:

$$Z = Z_{max.}\ (1 - 0.8 Z_{max.}/X) \qquad (2)$$

$$(\text{when } X > 2\, Z_{max.})$$

Density Difference Rise—The path of a plume due to density difference between the gas emitted from the stack and the surrounding atmosphere can be calculated by solving the simultaneous equations:

$$X = 3.57\, \frac{\sqrt{Q_1 u}}{V}\, x \qquad (3)$$

$$Z = 6.37 g\, \frac{Q_1 \Delta}{V^3 T_1}\, z \qquad (4)$$

where x and z are related as follows:

x	0	5	10	18	30	51	70	90	100
z	0	2	3	4	5	6	6.6	7	7.2

The path of a plume plotted from Eqs. (2), (3) and (4) neglects, of course, the effect of the temperature gradient. The latter factor must be considered since it governs the maximum height which the plume will attain.

Combined Effect of Density Difference and Temperature Gradient—The maximum height of a plume due to density difference and temperature gradient is given by

$$6.37 g\, \frac{Q_1 \Delta}{V^3 T_1}\, (\log_e J^2 + 2/J - 2) \qquad (5)$$

$$\text{where } J = \frac{V^2}{\sqrt{Q_1 u}} \left(0.43 \sqrt{\frac{T_1}{g G}} - 0.28\, \frac{u}{g}\, \frac{T_1}{\Delta} \right) + 1$$

Problems of Plume Height—In cases where only the maximum rise of a plume is of interest, Eqs. (1) and (5), plus the stack height, will give the desired result. That is:

$$\text{Maximum plume rise} = \frac{4.77}{1 + 0.43\, V/u} \times \frac{\sqrt{Q_1 u}}{V}$$

$$+\ 6.37 g\, \frac{Q_1 \Delta}{V^3 T_1}\, (\log_e J^2 + 2/J - 2) \qquad (6)$$

In problems in which the plume rise at a specific distance from the

NOMENCLATURE

- g Acceleration due to gravity, 32.17 ft./sec.²
- G Gradient of the potential atmospheric temperature, deg. C./1,000 ft. rise.
- H Actual stack height, ft. Effective height = H + plume rise.
- Q Actual gas quantity emitted from stack, cu. ft./sec.
- Q_1 Quantity of gas emitted from stack, converted to 20 deg. C., cu. ft./sec.
- T Actual gas exit temperature, deg. C. abs.
- T_1 Temperature at which gas density equals that of surrounding atmosphere, deg. C. abs.
- u Exit gas velocity, fps.
- V Wind velocity, fps.
- x Coordinate used in table accompanying Eqs. (3) and (4).
- X Horizontal distance from stack, ft.
- z Coordinate used in table accompanying Eqs. (3) and (4).
- Z Vertical plume rise above top of stack, ft.
- γ Actual rate of change of atmospheric temperature, deg. C./1,000 ft.
- δ Density of gas relative to air, both at 20 deg. C.
- Δ $T - T_1$.

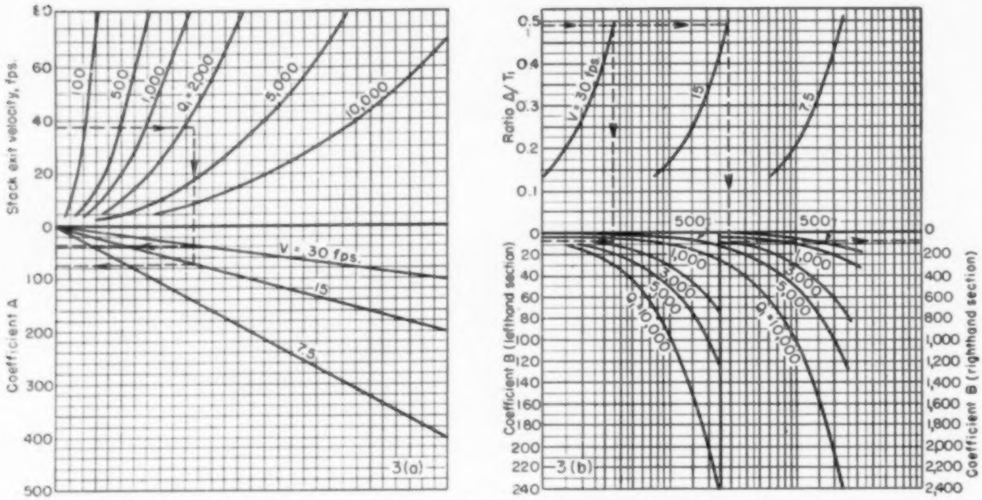

Fig. 3*a* and *b*—Coefficients *A* and *B* for determining plume rise due to density difference.

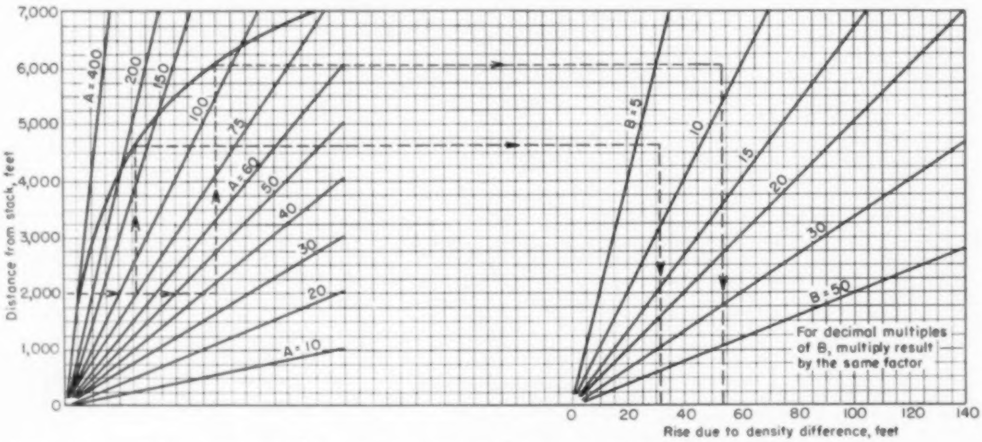

Fig 3*c*—Using coefficients *A* and *B* this chart solves Eqs. (3) and (4) for plume rise due to density difference.

stack is required Eqs. (2) (3) and (4) should be applied, but it is important to note that the latter do not take care of the effect of the gradient of the potential atmospheric temperature. For this reason it is also important to check these problems for maximum plume height (Eq. 6) and if the latter is found to be lower than the rise due to gas velocity and density only, an indication is obtained that the plume has attained its maximum height and the latter figure should be used in the ground concentration formulas.

The example given below will illustrate the method of solving problems in plume rise by means of the 10 handy graphs developed for this purpose.

Example—Find the plume rise at a distance of 2,000 ft. from the stack under the following conditions:

U = 37.5 fps.
T = 450 deg. C. abs.
Q = 2,320 cfs.
Q_1 = $QT_1/293$ = 2,400cfs.
δ = 1.03
G = 1.0 deg. C. per 1,000 ft.
V = 20 mph. and 10 mph.
= 30 fps. and 15 fps. (approx.)

The step-by-step solution is shown in the tabulation on the second page.

It will be noted that while the velocity rise has not yet attained the maximum height at 2,000 ft. from the stack, the rise due to density difference and temperature gradient has. If the total maximum rise of the plume is required the results in step 4 and step 13 should be added yielding heights of 42.6 and 90.5 ft. at wind velocities of 30 and 15 fps. respectively.

The example given shows clearly how stack heights can be reduced under certain conditions—with consequent monetary savings—and how advantage can be taken of the natural rise of the plume to increase dispersion of the pollutant.

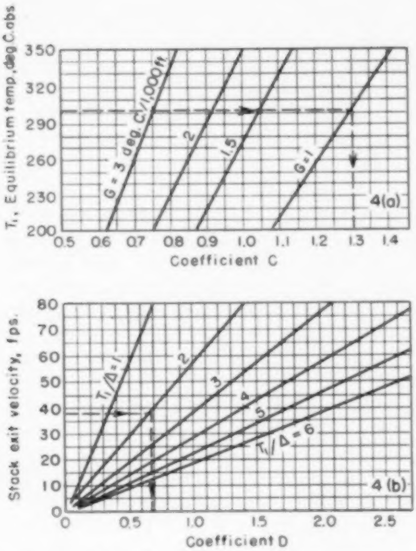

Fig. 4a and b—Give coefficients C and D for use in step 9.

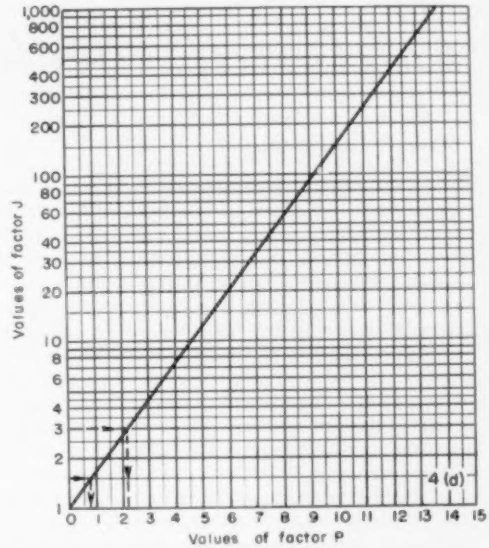

Fig. 4d—Gives factor P for use in step 11.

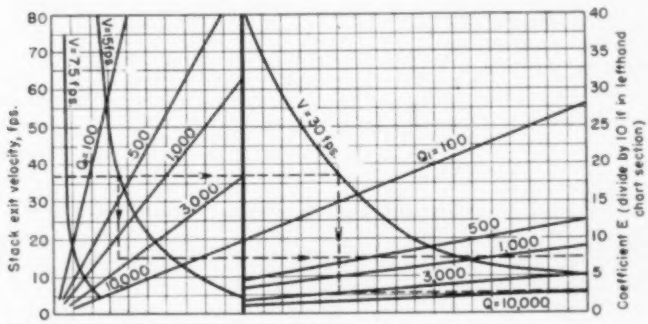

Fig. 4c—Gives coefficient E for use in step 9.

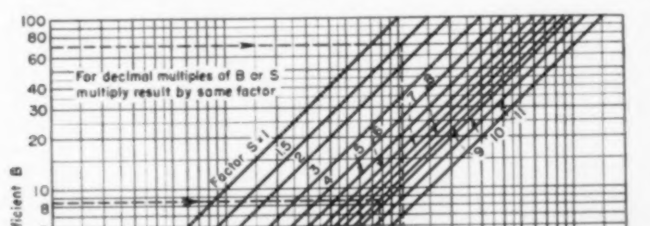

Fig. 4e—Gives maximum rise due to density difference and temperature gradient.

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Concerning Plume Rise

Bosanquet, Carey and Halton, *J. Inst. Mech. Engrs.* (London), Dec. 1950.

MEMO FROM THE EDITOR

Continued from page 133

ket researchers, college professors, research and development engineers, salesmen, production supervisors, operating engineers, advertising managers, technical service men, public relations personnel, advertising agencies, pilot plant operators, subscribers and non-subscribers, friends and critics.

But what did we get out of this week of "holiday" in Cincinnati?

We learned plenty. For one thing, we got an intimate feel of the area's chemical process industries, their everyday problems and ways of operating. Besides, we got to know many of the people who make these industries tick and what they think of the job we're doing.

And when it's all added up, we feel that the Cincinnati-type plant visits and conferences help us keep our finger on the pulse of the industry as well as to "see oursels as ithers see us." That's all we ask for.

Editorial Viewpoints

Whence the Money?

A year ago when questions about plans for capital expenditures, the chemical companies reported that more than ninety percent of their 1951 funds would come from depreciation reserves and retained earnings. This year fully a third of the companies expect to borrow from institutions or sell new securities to raise the money they need for expansion and modernization. In fact, chemicals were the only group in McGraw-Hill's fifth annual survey to rely heavily on equity financing. This is an encouraging commentary on the public's appraisal of chemical prospects. But it is also an admission that the industry's reserves are being eaten away by higher taxes and rising costs.

The big question: will taxes leave enough to pay the bills for new plants and equipment? It's sobering to realize that Uncle Sam took sixty percent of all corporate net income last year. Not much was left to be divided between stockholders and the growing needs for expansion and modernization. Yet our future economic strength and progress surely depend on the continued growth of basic industries such as those of the chemical process group.

Longer Payoff

Here's another significant finding in our 1952 survey: Over forty percent of all the companies reported that it takes longer now for an investment to pay off than it did only two or three years ago. Equipment costs are up, and taxes cut into the additional profit you get from more efficient processes and machinery. Many companies also say they have about exhausted their backlogs of obvious, quick-paying improvements resulting from earlier research. They are scraping the bottom of the barrel now for more marginal prospects that won't pay off in less than five to ten years. Thus the obvious conclusion: if profits continue to drop, a good many of the projects might be junked.

Do You Belong?

Our correspondence columns this month reveal a gratifying interest in the plan for honoring our long-time subscribers. Already a considerable rivalry has developed in some states and we may have to call in outside help to arbitrate the final awards. If by any chance you are one of those who has a longer record that those now included in our tentative Roll of Honor (see p. 258), we want to hear from you immediately.

For those "Old Timers" who missed the original announcement on page 158 of the January issue, here's the plot: This is our fiftieth year and in July we intend to celebrate appropriately with a golden anniversary issue. One of its features will be an honor roll of the longest continuous subscribers in each of the forty-eight states and principal foreign countries. (Inadvertently we omitted the District of Columbia and were properly called down by A. M. Houghton of Gulf Oil Corp. who has been a reader since 1905 and a continuous subscriber since February 1917. Our apologies, Mr. Patent Attorney!)

Henry W. Dahlberg of The Great Western Sugar Co. in Denver poses another problem. He has his personal bound copies of *Electrochemical and Metallurgical Industry* for the period October 1907 to June 1909 when he was an undergraduate at Minnesota. After that his employers took over and since April 1915 the "*Met. & Chem.*" subscription has been in the name of the technical library which has been under Dr. Dahlberg's supervision for most of the past 37 years. Do we hear any objections to thus personalizing Colorado's leading entry on the Roll of Honor?

But our most urgent need now is to hear from those of you who really belong on our honored list and are just too modest to tell us. Or can it be that you haven't gotten around to writing? A penny postcard costs only two cents.

Setting Up Two-Way Communication

President Jess Davis of Stevens Institute says that the average engineer suffers seriously from outstanding weaknesses in the fields of human relations and communication. These are closely related. Failure to progress satisfactorily in an organization most often results from inability to get along with other people—which in turn may depend on inability to communicate one's ideas to others. Recognizing these natural barriers to progress, many companies try to help younger engineers to do something about their deficiencies. Courses in writing and public speaking are helpful but usually inadequate. Other means must be found to aid in the personal development and growth of the individual. And since this is a responsibility of management, a lot of thought is now being given to all phases of communication within industrial organizations.

Johnson & Johnson of New Brunswick, N. J., is one of those to recognize and accept this challenge to management. It recently set up a six-man team of top executives to serve as a study panel. First the group gave themselves an intensive, practical course in the problems of communication within the company. Then they went to work and after hundreds of interviews and intra-

mural discussions, turned out a report that is already helping to break down the inherent barriers to better communications between management and employees. Here are some of the highlights of the panel's study:

"Listening and acting on the basis of what subordinates think, not what we think, is absolutely essential to realistic management. If management doesn't first dispel completely any feeling of disinterest or impatience —all of its group meetings, written reports and individual pat-on-the-back contacts are worse than useless." Other bottlenecks include the bosses who figure no news is good news. Actually lack of complaint or criticism is often symptomatic not of a happy organization but of poor communications upward . . . Managers who try to dodge the personal problems of their subordinates cannot expect understanding and support. Most serious of all is management's failure to act on unhappy conditions after they have been brought to its attention.

These are some of the organizational faults that cut off communication and block the path toward better human relations. To recognize these shortcomings and set about to improve them is most commendable. Engineers as well as all other employees can best develop in a climate of two-way communication.

Making Men Worth More

An intriguing question: Are higher salaries a cure for the current shortage of engineers? Certainly there are plenty of arguments in its favor—now and in the future. Better remuneration would tend to attract more youngsters into the profession—particularly those who question the values in higher education. Bigger paychecks might encourage the return of more mature engineers who have gone into sales or more profitable businesses of their own. Most important, higher salaries would undoubtedly stimulate better utilization of engineering talents too often wasted in non-engineering work.

In a recent address before the Wisconsin Society of Professional Engineers, John Gammell of Allis-Chalmers comes up with the simple idea that if engineers were worth more, they would get more. The problem, as he sees it, is to make them worth more—to their employers and to themselves. From his own experience, he sees good reason for industries to invest in in-plant training courses, in setting up additional fellowships and grants for university research and scholarships, for participating in correspondence courses and work-study training programs at both secondary and college levels.

But in the end, the problem of self-improvement is up to the engineer himself. There is nothing inherent in our profession that entitles us to more than we as individuals contribute to the proceeds of our work. It's not so much a question of dividing up the present pie as it is of having bigger and better pies to divide. And that's how engineers can often help most to make themselves worth more.

Mutual Respect and Confidence Needed

Government-industry relations in the operation of plants and research laboratories owned by Uncle Sam is a subject of increasing importance to our industry and profession. Recognizing this, the Chemical Engineers Club of Washington recently brought together three outstanding speakers to discuss the essentials for effective collaboration in such contracts. Carbide vice president George T. Felbeck gave the most concise description of the most needed point when he said, categorically, "Mutual respect and confidence are absolutely necessary."

But this takes more than merely a sound personal relationship. It requires a contract that fully complies with the law and which will stand up under the most careful audit by the General Accounting Office. This point of view was presented by Frank H. Weitzel, assistant to the Comptroller General. It was evident also from his remarks that GAO is no longer an inquisition agency. Now it is fortunately operated only to interweave sound commercial systems used by contractors with cooperative review to be sure that the taxpayer's money is legally spent.

No less significant is the military attitude as was presented by Undersecretary of the Army A. S. Alexander. The truly cooperative spirit was evident in his remarks as he pointed out that present contract practices are really only a part of the needed "technique of partial mobilization." By this he meant an effort to get what the Military needs, on time, in adequate quantity, at proper cost, but with a preservation of the civilian economy.

U.S. Tariff at Historic Low

Even though the tariff has long since lost much of its political glamour, the subject is certain to find a place in the party platforms and subsequent debates. With this imminence in mind, we were surprised to learn from a recent survey that the average level of our import duties is now down to its lowest point since the first U. S. Tariff Act of 1789. For what it's worth, we are now a "low-tariff" nation.

A recent study of the U. S. Tariff Commission based on 1949 imports shows that from the beginning of Cordell Hull's trade agreements program in 1934 to August 1, 1951, we reduced the duties on 82.7 percent of the total dutiable imports. On the average these rates were more than cut in half. Before 1934 the ad valorem equivalent was 27.7 percent; after August 1, 1951, it was 12.5 percent. Applied across the board to all dutiable imports, whether reduced, bound or untouched, today's average of 13.3 percent is the lowest ever recorded by the American Tariff League.

We must remember, too, that the United States imposes duties on less than half the merchandise arriving from abroad. Certainly we can no longer be called a "high-tariff" country.

New Thermodynamic Concepts Bring Theory and Practice Into Agreement

Revealing hitherto undetected fallacies in classical thermodynamics, this entirely fresh approach explains the discrepancies between theory and practice found in all flow problems.

NEIL P. BAILEY

NOTE: *Before reading this article, turn to p. 242 for Chemical Engineering's interpretation of its significance.*—EDITOR.

THIS article is a brief survey of the results of many years of sustained effort to improve the everyday usefulness of thermodynamic analysis and prediction. A far more complete presentation in book form is currently in press. In this book the rather simple physical approach to applied thermodynamics is extended into many areas not mentioned here.

The new book considers duct flow with friction and turbulence; flow with work input and heat release; other forms of discontinuities and instabilities; batch or intermittent processes, such as intake and exhausting of reciprocating engines. Even the power cycles of classical thermodynamics are much simplified by making it possible to follow actual processes as well as ideal ones.

New tables of gas properties, vapor properties and useful functions are now in preparation.

The Problem—Analyses of thermodynamic processes are plagued by many experimental observations that theory fails to explain or predict. Much effort goes to inventing correction factors that span an ever-widening gap between theory and practice. Measured flow rates don't check predictions, unexpected temperatures are found, unanticipated discontinuities and instabilities occur.

Classical thermodynamics, now a century old, was developed for static processes and ideal cycles. Basic concepts of fluid flow are essentially those of 1850 hydraulics. Modern engineering thermodynamics concocted from those two older subjects has not been built up as a consistent discipline.

Workers in this field come to an inescapable conclusion that somewhere along the line of development errors have crept into thermodynamic theory. In what follows these errors are isolated and the corrected analysis verified. The significance is worked out in several important areas of application and other implications are pointed out.

NEIL P. BAILEY *is professor and head of the mechanical engineering department at Rensselaer Polytechnic Institute, Troy, N. Y.*

Energy Concepts — Work is uniquely defined as a force acting through a distance. This is the only way that mechanical energy can be transmitted from one system to another. Moving fluid streams possess kinetic energy because they are flowing, and gases and vapors possess internal energy by virtue of molecular motion and spacing.

Liquids in elevated positions are often assumed to have energy attributable to their position, but they actually do not possess such energy. The elevation merely defines a state with respect to the earth. The liquids can receive this energy only as they move down hill and the force of gravity actually performs this promised work. If they never descend, they will never have this energy.

This contrasts with the true potential energy of a compressed spring. Here we have internally stored energy from elastic stress forces which have moved through deformation distances.

Fluids are often referred to as possessing energy because they exist under pressure. Again, this pressure merely defines a state and does not represent energy. A noncompressible fluid that will not deform can be raised to any pressure with zero work input—the force applied moves through no distance. When a gas or vapor is compressed, there is work input because the compressing force acts through a deformation distance. However, like the spring, this input work stays as internal energy in the gas. If work is done by release of this pressure, its only source is the stored internal energy. *A fluid at rest possesses only internal energy.*

Energy Flow — Energy can be moved from one place to another by a flowing stream in three ways. *Kinetic energy is transported* at a rate $Wv^2/2g$ by W lb. per sec. of fluid moving at velocity v ft. per sec. *Internal energy is transported* at a rate Wu by W lb. per sec. possessing u ft.-lb. per lb. of internal energy.

In addition, the fluid stream *transmits* energy at a rate Pav. An absolute pressure P across an area a constitutes a force Pa moving along at a flow velocity v.

This gives the total rate of energy flow WE as:

$$WE = Wu + Wv^2/2g + Pav \qquad (1)$$

Total = internal + kinetic + transmitted.

As a fluid flows along, exchanges between these three forms of energy can occur and the total WE can vary.

Transported kinetic and internal energy are obvious and measurable, but the *transmitted* energy flow Pav is less evident. Its existence can be seen by thinking of water flowing down a hill to a turbine through a constant-area pipe. As it comes down gravity does work on it, but its kinetic energy cannot change and its internal energy is negligible.

The work of gravity increases Pav by raising P. The entire work of gravity is delivered to the turbine as transmitted energy flow Pav. Stopping the flow stops the transmitted energy because the existing force Pa is not working and gravity does no work.

Energy Conversion — Transmitted energy Pav is not physically obvious but is very significant. Only through changes in it can there be changes in kinetic and internal energy. Kinetic energy can change only through a force change $d(Pa)$, and internal energy cannot change without a volume change $d(av)$.

In absence of turbulence or heat transfer, internal energy flow Wu can be changed mechanically only by a force acting through a deformation distance. This means that a change dV in the specific volume V must

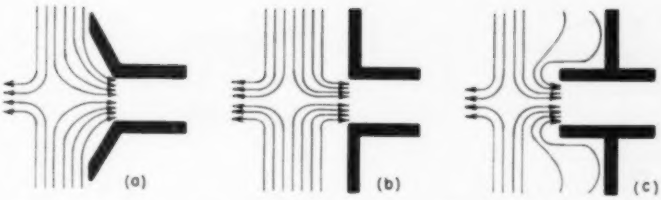


Fig. 1—Wall shape around a duct entrance affects flow characteristics; (a) partial nozzle with extra entering momentum; (b) plane tube, normal entering momentum; (c) re-entrant tube, reduced entering momentum.

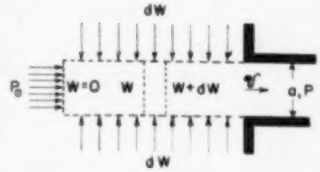


Fig. 2—Conditions defining flow of fluid in a "space tube," ready to enter nozzle. Space flow is at constant momentum.

occur with a pressure P if the internal energy is to be altered. For a steadily flowing fluid:

$$Wdu = -WPdV = -Pd(av) \qquad (2)$$

since for steady flow

$$WV = av \qquad (3)$$

Use the minus sign because a gain in volume $+ dV$ represents a loss in internal energy.

Change in volume flow av is made up of two parts:

$$Wdu = -Pd(av) = -Padv - Pvda \qquad (4)$$

The change adv is a space change in the flow direction, and vda is an expansion in a direction normal to the flow velocity. Both changes are with a pressure P so they both represent internal energy changes. But they have widely different effects on flow.

In classical thermodynamics, volume change dV was used as an algebraic quantity. This was all right in a closed engine cycle when only piston motion could give a volume change dV, but it cannot be so used with a flowing medium.

In the special case of a noncompressible medium, such as a liquid, dV is zero and vda must equal $-adv$.

Energy Conversion in Space Flow—Let us consider flow in free space, such as a wind blowing or fluid flowing in a large space toward an opening or around an obstruction. A flow tube is surrounded by an imagined boundary enclosing a varying flow area inside of which there is always a statistically constant flow of molecules. Constant-weight flow, W lb. per sec., in such a tube must accelerate and decelerate in equilibrium with surrounding tubes if turbulence and mixing are to be avoided.

In such a tube, energy conversion $Padv$, Eq. (4), is in the direction of flow and can change the transmitted and kinetic energy. The transverse energy conversion $Pvda$ is absorbed or supplied by adjacent flow tubes.

To say that the imagined molecular boundary of a tube could retain or reflect such transverse expansion energy would deny the very molecular process by which expansion occurs and internal energy changes are brought about.

This means that with space flow, even though an amount of internal energy Wu is being transported, only the energy change $-Padv$ affects the transmitted and kinetic energy. The transverse energy change $-Pvda$ represents an exchange between flow tubes. For space flow, Eq. (1) becomes:

$$d(WE) = d(Wu) + d(Wv^2/2g) + d(Pav) \qquad (5)$$

$$-Pvda =$$

$$-Pvda - Padv + d(Wv^2/2g) + d(Pav) \qquad (6)$$

$$(W/g)vdv + vd(Pa) = 0 \qquad (7)$$

Since $v = 0$ is not a significant solution with flow

$$(W/g)dv + d(Pa) = 0 \qquad (8)$$

Eq. (8), derived for space flow from an energy approach, can be recognized as a constant-weight flow version of Newton's second law. The rate of change of momentum equals the applied force, or

$$d(Wv/g) + d(Pa) = 0 \qquad (9)$$

This says that for space flow where there are no forces exerted by duct walls, flow is at constant momentum.

Energy Conversion in Duct Flow—When a steady-weight flow W lb. per sec. of fluid is guided non-turbulently by the solid walls of a duct, the energy conversion is somewhat different. As before, the energy change $-Padv$ acts directly to alter the kinetic and transmitted energy. The transverse energy conversion $-Pvda$, which was exchanged between flow tubes in space, is now contained within solid duct walls. Through the mechanism of molecular reflections at the solid walls, this transverse energy change is redirected into the flow direction.

This means that the total energy flow WE of Eq. (1) is constant, so

$$-Pd(av) + d(Wv^2/2g) + d(Pav) = 0 \qquad (10)$$

$$(W/g)vdv + avdP = 0 \qquad (11)$$

Again, since $v = 0$ is not a significant solution, and since for steady flow

$$WV = av \qquad (12)$$

duct flow is defined by

$$(vdv/gV) + dP = 0 \qquad (13)$$

Eq. (13) for duct flow is usually derived from a force point of view by summing up forces on an element in the flow direction. Because the same force diagram is always drawn, it has been assumed to apply also to space flow.

However, an energy approach makes it clear that:

a. *Flow in ducts is at constant energy and variable momentum.*

b. *Flow in space is at constant momentum and variable energy.*

Flow From Rest—Fluid flowing in any duct must at some point enter from a large space. This entering process is of primary importance. At rest in space a fluid possesses only internal energy regardless of the pressure at which it exists. Pressure does influence the amount of energy that can be removed from a space by a flowing fluid, but the only source of such energy is the internal energy stored in the space or the energy source supplying fluid to the space.

From Eqs. (1) and (3) the rate of energy flow into an opening of area a is:

$$\frac{WE}{a} = \frac{uv}{V} + \frac{v^3}{2gV} + Pv \qquad (14)$$

This changes with varying velocity, depending on how velocity affects the leaving pressure and internal energy.

The manner of this variation is influenced somewhat by the way the walls direct the entering flow, Fig. 1. The most common and important case[6,7] is the plane entrance of Fig. 1(b). For this case, the only entering momentum is that supported by the supply pressure P_o.

When W lb. per sec. of fluid flows in a tube in space, Eq. (9) gives the condition at any point as

$$(Wv/g) + Pa = constant \qquad (15)$$

This form of the constant momentum equation is useful for studying the flow of Fig. 2 by combining it with Eq. (3) to give

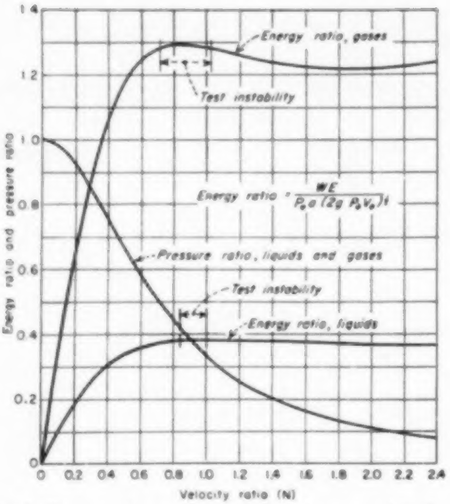


Fig. 3—Energy and pressure ratios for flow from space into ducts. Note regions of instability.

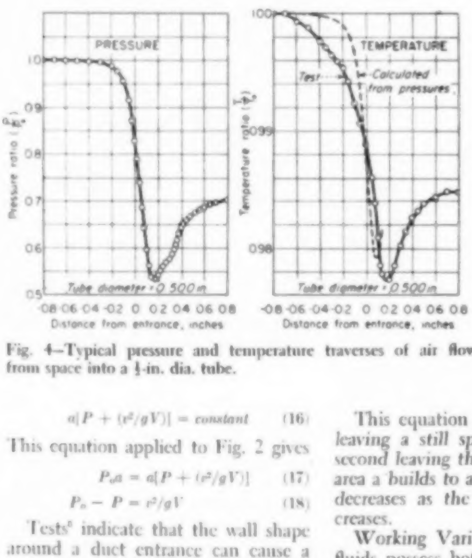


Fig. 4—Typical pressure and temperature traverses of air flow from space into a ½-in. dia. tube.

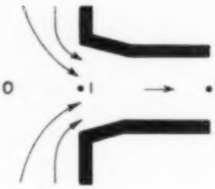


Fig. 5—Flow nozzle numbered with sequence of points assists in development of equations distinguishing space flow from duct flow.

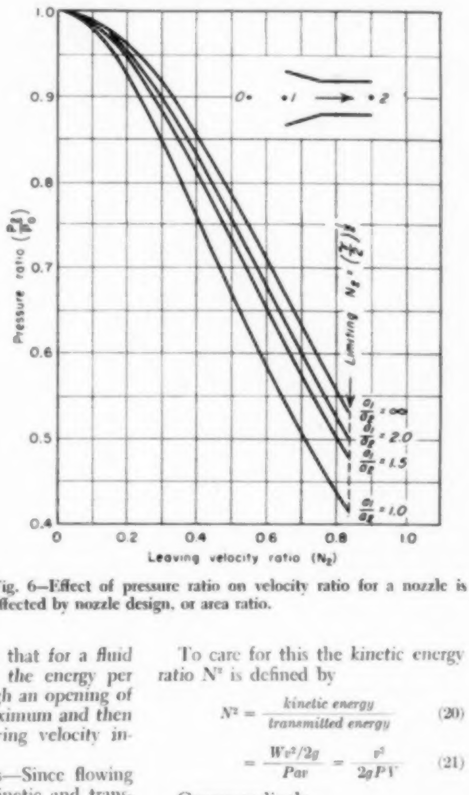


Fig. 6—Effect of pressure ratio on velocity ratio for a nozzle is affected by nozzle design, or area ratio.

$$a[P + (v^2/gV)] = constant \qquad (16)$$

This equation applied to Fig. 2 gives

$$P_o a = a[P + (v^2/gV)] \qquad (17)$$

$$P_o - P = v^2/gV \qquad (18)$$

Tests[8] indicate that the wall shape around a duct entrance can cause a variation of as much as plus or minus 20 percent in the pressure drop ($P_o - P$) required to produce a flow velocity v into a duct opening. Value for a plane entrance given by Eq. (18) may be safely taken as a normal condition, because the maximum variations observed do not all change the nature of the conclusions that follow from combining Eqs. (14) and (18) to give

$$\frac{WE}{a} = \frac{uv}{V} + P_o v - \frac{v^3}{2gV} \qquad (19)$$

This equation says that *for a fluid leaving a still space, the energy per second leaving through an opening of area a builds to a maximum and then decreases as the leaving velocity increases.*

Working Variables—Since flowing fluids possess both kinetic and transmitted energy, the flow situation is not defined without specifying both of them. A certain amount of kinetic energy with a low transmitted energy will not result in the same flow situation as the same kinetic energy with a higher transmitted energy.

This means velocity v alone is not a proper variable to use in studying flow. It is vital to consider the pressure P that accompanies the velocity; otherwise transmitted energy is not defined.

To care for this the kinetic energy ratio N^2 is defined by

$$N^2 = \frac{kinetic\ energy}{transmitted\ energy} \qquad (20)$$

$$= \frac{Wv^2/2g}{Pav} = \frac{v^2}{2gPV} \qquad (21)$$

Correspondingly,

$$Internal\ energy\ ratio = Wu/Pav = u/PV \qquad (22)$$

Another very useful concept is

$$N = velocity\ ratio$$

$$= \sqrt{kinetic\ energy\ ratio}$$

$$= v/\sqrt{2gPV} \qquad (23)$$

In terms of these ratios, entering pressure ratio for all fluids from Eq. (18) is defined by

$$P_o/P = 1 + 2N^2 \qquad (24)$$

When gases and vapors undergo

internal energy changes, value of the transmitted energy during the conversion is significant. Another very useful concept is

$$\text{Conversion factor} = \int \frac{W du}{Pav} = \int \frac{du}{PV} \quad (25)$$

Liquid Flow Into Ducts—For liquids, internal energy u is considered zero and energy flow Eq. (19) takes the form

$$\frac{WE}{a} = P_o v - \frac{v^3}{2gV} = Pv\left(\frac{P_o}{P} - \frac{v^2}{2gVP}\right) \quad (26)$$

This may be written

$$\frac{WE}{P_o a(2gP_oV)^{1/2}} =$$

$$\left(\frac{P}{P_o}\right)^{3/2} \frac{v}{(2gPV)^{1/2}}\left(\frac{P_o}{P} - \frac{v^2}{2gPV}\right) \quad (27)$$

Combining this with Eq. (24)

$$\frac{WE}{P_o a(2gP_oV)^{1/2}} = \frac{N(1+N^2)}{(1+2N^2)^{3/2}} \quad (28)$$

This, with Eq. (24), completely defines the energy flow of a liquid entering a duct from a pressure P_o for normal entrance of Fig. 1(b).

Fig. 3 shows that maximum possible energy flow of a liquid from a free space occurs at a velocity ratio of $N = 1.0$ and under pressure ratio $P/P_o = \frac{1}{3}$. Careful tests[2,3] of straight tubes of length-diameter ratios of 1.0 to 4.0 show instability in the range given on Fig. 3.

Below $P_o/P = 3.0$ and $N = 1.0$, the tube flows full, and at or near $N = 1.0$, the flow breaks clear of the tube walls. Simultaneously a high-pitched whistling begins, indicating an instability at the zero slope point of Fig. 3. At higher pressure ratios the jet remains separated, and between P_o/P of 4 and 5 the whistle passes out of the audible range (12,000 cycles per sec.).

Upon again reducing the pressure ratio carefully to a value less than P_o/P of 3.0 the jet often remains separated for a time in a metastable state. In the range just below $P_o/P = 3.0$, straight-walled tubes are extremely unstable.

Gas Flow Into Ducts—When a gas flows from a space into a duct both the specific volume V and the internal energy u change so the complete energy flow equation, Eq. 14, must be used. This can be written as

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}} =$$

$$\left(\frac{P}{P_o}\right)^{3/2}\left(\frac{V}{V_o}\right)^{1/2} N\left(\frac{u}{PV} + N^2 + 1\right) \quad (29)$$

where P_o and V_o refer to conditions in the supply space. Pressure required is given by Eq. (24).

Specific volume V and internal energy u can be related for a gas through the conversion factor of Eq. (25). For no heat transfer or turbulence

$$du = -PdV \quad (30)$$

$$-\int \frac{dV}{V} = \int \frac{du}{PV} \quad (31)$$

For an ideal gas

$$PV = RT \text{ and } du = JCdT \quad (32)$$

where T is temperature in deg. R., and C is internal energy specific heat. Eqs. (31) and (32) can be combined with

$$\gamma = \frac{R}{JC} + 1 = 1.4 \text{ for air} \quad (33)$$

to give the familiar relationship

$$\left(\frac{V_o}{V}\right)^{\gamma} = \frac{P}{P_o} \quad (34)$$

This gives, for an ideal gas, the following relationship:

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}}$$

$$= \left(\frac{P}{P_o}\right)^{3/2}\left(\frac{P}{P_o}\right)^{-1/2\gamma} N\left(\frac{JC}{R} + 1 + N^2\right) \quad (35)$$

Using Eq. (24)

$$\frac{WE}{aP_o(2gP_oV_o)^{1/2}} = \frac{N\left(\frac{\gamma}{\gamma - 1} + N^2\right)}{(1+2N^2)^{3/2-1/2\gamma}} \quad (36)$$

Energy flow of a gas entering an opening from a supply pressure P_o shown by Fig. 3 reaches a maximum at $N = (\gamma/2)^{1/2}$ and $P_o = 1+\gamma$, and a minimum at $N = [\gamma/(\gamma-1)]^{1/2}$, after which it again increases.

Repeated tests of many tubes show instability always at the top of the energy flow curve, as on Fig. 3. In the previous case of water, the jet separated from the tube walls, but with air, instability takes another form. The flow surges violently, appearing to completely collapse and reform each cycle. The frequency is lower than for water and heavy energy surges are involved.

Fig. 4 shows typical traverses for such a tube with a pressure ratio just before bad instability starts.

Liquid Nozzles—Space flow of a liquid into a straight-walled tube becomes unstable at an absolute pressure ratio of $P_o/P_1 = 3.0$ because this point represents the maximum energy flow that can enter the duct.

Requirements for a stable liquid nozzle can be deduced from Fig. 5, in which the flow from P_o to P_1 is space flow at constant momentum. Flow from P_1 to P_2 is duct flow at constant energy. From Eqs. (19) and (14)

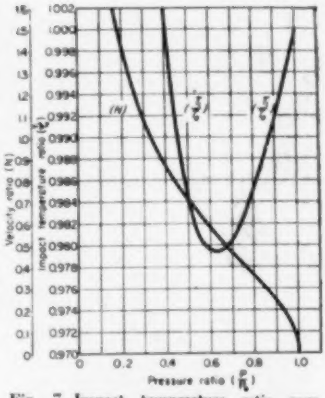


Fig. 7—Impact temperature ratio goes through a minimum as pressure ratio is increased.

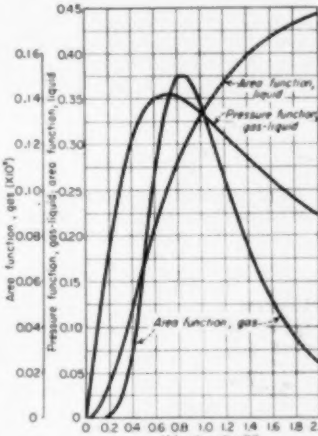


Fig. 8—Area and pressure functions for space flow can be readily calculated from these curves.

for a liquid, the entering energy at 1 is the same as that leaving at 2.

$$WE = P_o v_1 a_1 - \frac{v_1^3 a_1}{2gV}$$

$$= \frac{a_2 v_2^3}{2gV} + P_2 a_2 v_2 \quad (37)$$

For steady flow

$$WV = a_1 v_1 = a_2 v_2 \quad (38)$$

$$\frac{P_o}{P_1} - N_1^2 = \frac{N_1^2 a_1^2}{a_2^2} + \frac{P_2}{P_1} \quad (39)$$

Critical entering condition occurs when

$$N_1^2 = 1.0 \text{ and } P_1 = P_o/3 \quad (40)$$

This gives a critical pressure ratio for any area ratio

$$\left(\frac{P_2}{P_o}\right)_{critical} = \frac{2 - a_1^2/a_2^2}{3} \quad (41)$$

This says that while a straight-walled tube becomes unstable at $P_2/P_o = \frac{1}{3}$, a tube with a taper of $a_1/a_2 = (2)^{1/2}$ will have no critical pressure ratio.

The following table gives a summary of many tests of tapered tubes:

a_1/a_2	Critical P_2/P_o Theory	Critical P_2/P_o Test
1.0	0.33	0.38
1.21	0.18	0.28
1.44	none	none

A taper of a_1/a_2 of 1.44 resulted in a tube that could not be put into instability, as predicted. Tests on tubes of area ratio a_1/a_2 of 1.0 and 1.21 became unstable at lower than predicted values of P_o/P_2, primarily because of the flat-topped nature of the energy-flow curve.

Since about 1860 it has been accepted practice to assume space flow is at constant energy, the same as duct flow. Eq. (13) has been applied to the nozzle of Fig. 5 to give

$$\frac{1}{gV}\int_o^{v_2} v\,dv + \int_{P_o}^{P_2} dP = 0 \quad (42)$$

or,

$$\frac{v_2^2}{2gV} = P_o - P_2 \quad (43)$$

The discharge so calculated has failed to check tests, so a discharge coefficient C_D was then used to give

$$\text{Flow rate} = C_D a_2 \left[2gV(P_o - P_2)\right]^{1/2} \quad (44)$$

However, using space flow ahead of the nozzle from Eqs. (37) and (38) gives

$$P_o - \left(\frac{a_2}{a_1}\right)^2 \frac{v_2^2}{2gV} = \frac{v_2^2}{2gV} + P_2 \quad (45)$$

or,

$$\text{Discharge rate} = a_2 v_2$$

$$= a_2\left[\frac{2gV(P_o - P_2)}{1 + \frac{a_2^2}{a_1^2}}\right]^{1/2} \quad (46)$$

Comparing Eqs. (44) and (46)

$$\frac{1}{C_D} = \left(1 + \frac{a_2^2}{a_1^2}\right)^{1/2} \quad (47)$$

The following table shows typical test results for small tubes of a length-diameter ratio of 4.0:

a_1/a_2	Test C_D: Below critical (full)	Test C_D: Above critical (separated)	Calculated C_D Eq. (45)
1.00	0.81	0.63	0.71
1.21	0.88	0.76	0.77
1.44	0.91	0.91(stable)	0.83

Comparison should be made between the calculated values and the test values below the critical. Assumption that space flow ceases and duct flow begins immediately at point 1, Fig. 5, does not square with test observations. Space flow appears to persist some into entrance of tube, so more energy actually enters than was assumed.

Gas Nozzles—When a gas flows into a nozzle, Fig. 5, the fact that it is constant-energy duct flow from 1 to 2 is stated by

$$WE = Wu_1 + W\frac{v_1^2}{2g} + P_1 a_1 v_1$$

$$= Wu_2 + W\frac{v_2^2}{2g} + P_2 a_2 v_2 \quad (48)$$

Using Eqs. (33) and (34) gives

$$\frac{P_1}{P_2}\left(\frac{\gamma}{\gamma - 1} + N_1^2\right)^{\gamma/(\gamma-1)}$$

$$= \left(\frac{\gamma}{\gamma - 1} + N_2^2\right)^{\gamma/(\gamma-1)} \quad (49)$$

The steady-flow equation

$$W = \frac{a_1 v_1}{V_1} = \frac{a_2 v_2}{V_2} \quad (50)$$

may be written as

$$\frac{a_1 N_1}{a_2 N_2} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{2\gamma}} \quad (51)$$

These can be combined to give

$$\frac{N_1}{\left(N_1^2 + \frac{\gamma}{\gamma - 1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}}\,\frac{a_1}{a_2} = \frac{N_2}{\left(N_2^2 + \frac{\gamma}{\gamma - 1}\right)^{\frac{\gamma+1}{2(\gamma-1)}}} \quad (52)$$

Function of N_2 of Eq. (52) reaches a maximum value at $N_2 = (\gamma/2)^{1/2}$, so for any nozzle a_1/a_2 the entering velocity ratio N_1 cannot become greater than that corresponding to an N_2 of $(\gamma/2)^{1/2}$.

Physically, this means that as P_o, the supply pressure, is raised, the pressure ratio across the nozzle and its approach will not exceed a value to produce this N_2. Further increases will only cause P_2 to rise.

Eqs. (49) and (51) can be solved in many ways, together with the space flow equation

$$P_o/P_1 = 1 + 2N_1^2 \quad (53)$$

One very useful form, Fig. 6, shows that the velocity ratio N_2 produced by an over-all pressure ratio P_2/P_o depends on the area ratio a_1/a_2 of the nozzle. Also, it shows that the critical pressure ratio at which N_2 reaches a maximum of $(\gamma/2)^{1/2}$ depends on the nozzle design. It is small wonder that so many values of nozzle coefficients have been necessary in the past. The conclusions of Fig. 6 are well substantiated by tests.

Temperature Concepts—It has been the custom to assume that a liquid flowing from a region at pressure P_o removes with it an amount of energy P_oV_o per lb. However, it can be shown that with space flow

$$\frac{E}{P_oV_o} = \frac{1 + N^2}{1 + 2N^2} \quad (54)$$

where N is the leaving velocity ratio. This varies from unity at an N of zero to a minimum of $E/P_oV_o = \frac{2}{3}$ at the limiting leaving N of unity.

With ideal gases it has always been assumed that the energy removed per lb. is

$$E = JCT_o + P_oV_o = \frac{P_oV_o}{\gamma - 1} + P_oV_o \quad (55)$$

or,

$$\frac{E}{P_oV_o} = \frac{\gamma}{\gamma - 1} \quad (56)$$

It can be shown that with space flow

$$\frac{E}{P_oV_o} = \frac{\frac{\gamma}{\gamma - 1} + N^2}{(1 + 2N^2)^{(\gamma-1)/\gamma}} \quad (57)$$

This varies from a maximum of E/P_oV_o of $\gamma/(\gamma-1)$ at a leaving N of zero to a minimum value of $[\gamma(1+\gamma)^{1/\gamma}]/[2(\gamma-1)]$ at the maximum stable leaving velocity ratio of $N = (\gamma/2)^{1/2}$.

Temperature concepts can be readily visualized in terms of Eq. (1).

The *static temperature* T measures only internal energy u and is not conscious of transmitted or kinetic energy. A stationary thermometer, which reads *impact temperature* T_i, is not aware of transmitted energy Pav, which can only be calculated.

Ratio of impact temperature T_i to original supply temperature T_o is

$$\frac{T_i}{T_o} = \frac{Wu + W\frac{v^2}{2g}}{Wu_o}$$

$$= \frac{PV}{P_oV_o}\,\frac{\left(\frac{u}{PV} + \frac{v^2}{2gPV}\right)}{\frac{u_o}{P_oV_o}} \quad (58)$$

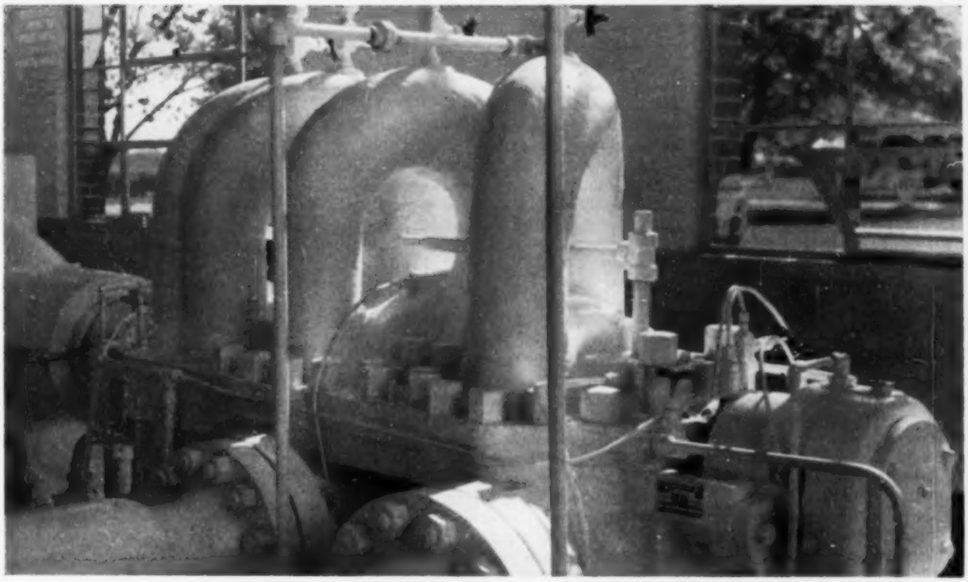
For space flow into a duct

$$\frac{T_i}{T_o} = \left(\frac{P}{P_o}\right)^{(\gamma-1)/\gamma}\frac{\left[\frac{1}{\gamma - 1} + N^2\right]}{\frac{1}{\gamma - 1}}$$

$$= \left(\frac{P}{P_o}\right)^{(\gamma-1)/\gamma}\left[1 - \frac{\gamma - 1}{2}\left(\frac{P_o}{P} - 1\right)\right] \quad (59)$$

Fig. 7 for air shows that with space flow T_i/T_o has a minimum value of 0.979 at a pressure ratio $P/P_o = 1/(3 - \gamma) = 0.625$ corresponding to $N = 0.546$. Fig. 4 shows typical experimental values and a comparison

(*Continued on page 336*)



PUMPS

Pump selection is rapidly becoming more specialized. To help the chemical engineer make the best selection, here is a handy and definitive classification of all types of pumps, with special emphasis given to the chemical pump.

CHEMICAL ENGINEERING REPORT — MARCH 1952

R. E. DOLMAN

Development of pumps permitted civilization to move away from the rivers and springs, and develop the vast land areas that were previously uninhabitable. When man learned how to move large quantities of water, he was able to irrigate arid lands and develop new, larger and healthier agricultural crops.

The ancient Chinese invented human-powered, animal-powered and water-powered devices for lifting water from the rivers to irrigate crops. These consisted usually of large ladles or buckets.

Over 5,000 years ago the Egyptians built what was probably the first "deep-well" pump. The well, known as Joseph's Well, and still in existence at Cairo, consists of two rectangular sections, like mine shafts, one above and offset from the other.

Water was picked up by a series of earthen pots fastened to an endless rope, like our modern bucket elevators, and raised to the top of the lower shaft where it was dumped into a basin at the bottom of the upper shaft. A second "chain of pots" in the upper shaft lifted the water to the surface. The chain of pots was carried on pulleys which were driven through crude wooden gears by "walk around" levers powered by oxen or slaves.

The Romans made considerable progress in the art of pumping water. In about 200 B.C., they built small, hand-operated piston or plunger pumps with poppet valves, the world's first "force," or pressure pump, very similar in principle and general appearance to some pumps built today.

The plunger pump was further developed in Europe, and by the 17th to 18th centuries was being built in rather large sizes. Some were steam piston-powered, and used for raising water from wells, coal mines, and low lands.

The first crude attempt at building a pump using centrifugal force to move liquid came in about the year 1680, but the real developments in pump design and performance have taken place only in the last 100 years or so.

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To illustrate the part pumps play in our everyday life, consider your automobile and the gasoline it uses. Several different types of pumps are used on the oil well drilling rig. If the oil field is an older one, the oil may have to be floated out with water. This requires a water well from which water must be pumped by means of a deep-well turbine pump. Then a plunger pump, probably triplex, pumps the water back down a pressurizing well to a point below the oil layer, thus floating the oil up to an elevation where a plunger pump in a third well then lifts the oil to a surface hold-up tank.

Gathering pumps, either piston or centrifugal, pump the crude to a large storage tank, then larger, high-pressure "centrifugals" pump it through transmission lines direct to the refinery. Or, another type of pump may load it into tankers from which it will be unloaded by a still different type at the refinery.

The transformation of crude oil to gasoline in the modern refining process requires a multitude of different types and sizes of pumps not only for direct handling, but also indirectly for pumping boiler feedwater, water treatment chemicals, condensate, cooling water, etc.

The final product is pumped to storage tanks, then other pumps load it into tank trucks for transport. Pumps on the trucks unload it into the tanks at the local service station. A different type then pumps the gasoline into the tank in your automobile. Last but not least, the fuel pump in your auto forces the gas into the engine.

Pumps are made in a wide range of types: plunger, centrifugal, propeller, turbine vane, jet, gear, screw, cam, diaphragm, to mention only a few, and with many variations of each. They are also made in a great variety of materials for handling various liquids.

Materials of construction include all common machinable metals and alloys, such as gray cast iron, nickel cast iron, carbon steel, tool steels, chrome steel, chrome-nickel steels, nickel and high-nickel alloys, aluminum, magnesium, several tin bronzes, aluminum bronzes, lead, zinc alloys. Pumps are also made of several alloys so hard that they can be machined only by grinding, such as the high-silicon irons.

But, we are not limited to metals. Complete pumps or major parts are being made of such non-metallics as hard rubber, soft rubber, synthetic rubbers, various plastics including nylon, Teflon, Polythene, Lucite, phenolic and furane resins, polyvinyls, glass, various porcelain or ceramic materials, carbon, and probably others. The development of pumps built of special materials has made possible many new processes that were previously impractical.

The range of sizes in which pumps are built is also wide, probably wider than most people, even engineers, realize. For example, capacities vary from several milliliters per hour, required for some laboratory pumps, to the $\frac{3}{4}$ million gallons per minute that rush through each of the new pumps for irrigation service at Grand Coulee Dam. Some of the small gear pumps used in aircraft weigh but a few ounces and consume as low as 1/250 hp., while impellers alone weigh 30 tons in the Grand Coulee pumps, and are driven by 65,000 hp. vertical electric motors, the largest in the world. The inlet and outlet connections used in these pumps vary from $\frac{1}{8}$ in. standard pipe size (the smallest practical size for common use) to 14 ft. at Grand Coulee.

As for temperatures, modern pumps are regularly built to handle liquids up to 850 deg. F., and some special pumps have operated to 1,500 deg. F.

Great progress in pump design has been made, especially during and since World War II. But the pump industry faces a challenge in keeping up with the great strides of the chemical industry, with accompanying problems of corrosion, abrasion, accurate control, continuous duty for long periods, and so on. The pump designers have not run out of problems yet.

Positive Displacement Pumps

Pumps that make use of the positive displacement principle can be divided into two general classes, reciprocating and rotary.

RECIPROCATING

Principle

A plunger, or diaphragm reciprocates, resulting in an alternating increase and decrease in volume of the pump body or case Fig. 1. As the plunger withdraws, suction pressure forces liquid to enter the pump; then as the plunger returns, it displaces the liquid, forcing it out the discharge. Check valves in suction and discharge prevent backflow. The plunger pump is the oldest type still in common use.

Basic Types

1. Direct-Acting (Piston or Plunger) Fig. 3. Section views. The piston or plunger is driven by a second, double-acting piston at the other end of a common piston rod. They are classified by:

a. Power—The power piston is driven by steam, air or hydraulic oil from an external pressure supply. The modern direct-acting steam pump was developed in about 1840, with only minor changes since.

b. Number and type of cylinders—Usually one or two cylinders, can be single- or double-acting.

c. Horizontal or vertical.

d. Fluid-end arrangement.
   (1) Piston, Fig. 3, or plunger.
   (2) Outside-packed, inside-packed or ring-sealed.
   (3) Differential piston.

e. Valve arrangement.
   (1) Cap and plate.
   (2) Side pot.
   (3) Turret, etc.

2. Power—Piston or plunger driven by any external power source through cranks, or eccentrics, Fig. 5, 6. Result of the development of new rotary power sources—electric motor, turbine, internal combustion engine. Power pumps are usually classified by:

a. Whether piston Fig. 5 or plunger, Fig. 6 and arrangement (horizontal, vertical, inverted).

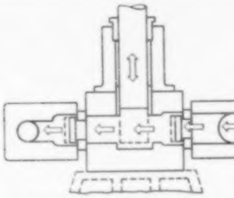
b. Single, Fig. 6, or double acting fluid end.

c. Number of cranks or eccentric throws (Fig. 7 shows partial section through vertical triplex power pump).

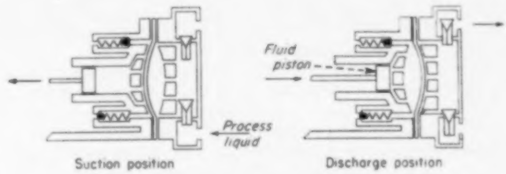
d. Open, semi-enclosed, or enclosed frame.

e. Fixed or variable stroke, or speed.

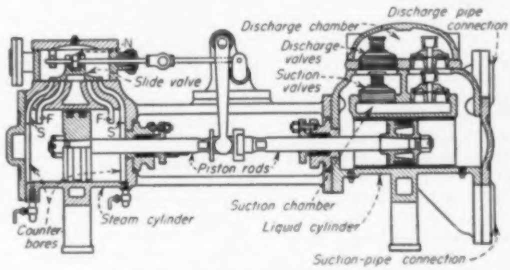
3. Diaphragm—These might be included in the Direct-Acting or Power groups, except for certain peculiarities. The diaphragm is the only connection between the driving mechanism and the fluid being pumped, and is used to contain the fluid, eliminating packing. It simply floats between drive and fluid, isolating one from the other. The diaphragms are actuated by compressed air or oil from an external supply, by oil that is pumped by a piston within the pump itself, Fig. 2, or by an entirely mechanical device consisting of a piston or telescoping sleeves that deflect and support the diaphragm, Fig. 4. All types have check valves, like any reciprocating pump. The oil piston type is just like a plain piston power pump, except that the piston and packing work against oil, which is separated from the process fluid by a flexible diaphragm. The oil simply acts as a



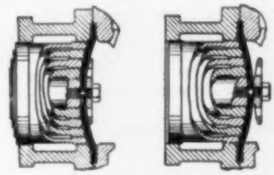
(1) Principle of reciprocating pump



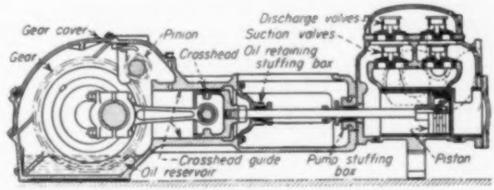
(2) Principle of fluid-operated diaphragm pump



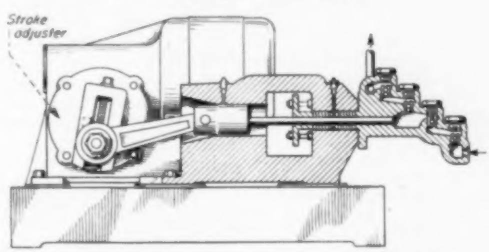
(3) Direct-acting steam pump



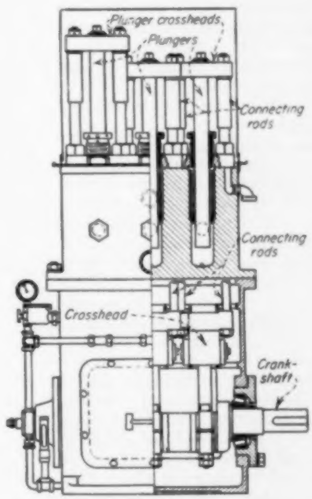
(4) Principle of mechanical diaphragm pump



(5) Piston-type power pump



(6) Plunger-type power pump with adjustable stroke



(7) Inverted vertical triplex power pump

cushion between piston and diaphragm, transmitting the force.

4. Blow Case—In passing, we should include this classic device, used principally for pumping acids before good packings and seals were developed, and no longer in wide use. It consists of a tank filled with liquid by gravity. Valves are changed, automatically or manually, admitting air or inert gas under pressure high enough to blow the liquid out the discharge line. These pumps are normally used in pairs to obtain steady flow. The air or gas can be considered as a reciprocating piston.

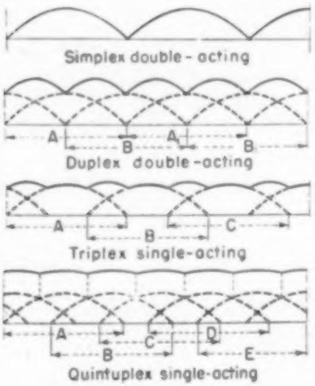
Characteristics

Outstanding operating characteristic of each of the above basic types of reciprocating pumps is, according to type:

1. Direct Acting Pump—flow pattern tries to conform to the pumping system. High head and low capacity compared to centrifugal.

2. Power Pump—has a definite flow pattern determined by crank or eccentric design, connecting rod length and number of cylinders, Fig. 8. Used for any heads up to highest, and relatively low capacities. Flow pattern can be smoothed out by use of air cushion chamber.

3. Diaphragm Pump—flow pattern may be either of above types, depending on the drive. If air, steam or hydraulic, it will conform to the system. If the drive is a mechanical piston with or without an oil cushion, the flow pattern will be definite. Usually used for moderate heads, low capacities.



(8) Reciprocating flow patterns

Size

1. Horsepower—fractional to about 2,500 hp.

2. Performance Range.
   a. Pressures to 50,000 psi., occasionally higher. Also vacuum to 26 in.
   b. Capacities to about 1,800 gal. per min.
   c. Viscosities to about 100,000 S.S.U.

Materials of Construction

Suitable materials of construction of reciprocating pumps are limited because of the moving parts, rubbing contact, and complex and bulky casings, especially in piston pumps. Cast iron, steel, and bronze are the usual materials for direct-acting piston pumps and power piston pumps. Power plunger pumps are sometimes built of various stainless steels and special alloys. Small sizes are available with plastic heads. Diaphragm pumps usually have diaphragms of synthetic or natural rubber, steel or stainless steel; and casings usually of cast iron, bronze, steel or stainless; but can be built of any machinable alloy. Casings and valves have also been built of ceramics and plastics.

Valves

Valves for reciprocating pumps are built in a great variety of designs and materials, depending on the corrosion, viscosity, and solids or abrasive content of the fluid handled. Materials of the valve parts range from rubber and plastics through a wide choice of metals to such hard materials as sintered carbides, ceramics, glass and synthetic sapphire.

Control of Capacity

1. Direct-Acting—Control of speed by throttling steam (or air, or by regulating oil) to power cylinder. Manual or automatic.

2. Power.
   a. Start-stop.
   b. Variable speed drive.
   c. Variable stroke. Fig. 6.
   d. By-pass.
   e. Synchronized suction-valve unloading (all of above can be manual or automatic).

3. Diaphragm—If air or steam operated, by throttling. If oil piston operated, by:
   a. Start-stop.
   b. Variable-speed drive.
   c. Variable stroke.
   d. By-pass.

4. Blow Case—Control of air (or gas) flow.

Typical Applications

1. Direct-Acting and Power Pumps.
   a. Oil fields—drilling slush, deep-well, flooding, gathering and pipelines.
   b. Refineries—volatile liquids, viscous liquids, general service.
   c. Power Plants—boiler feed, water treatment (small pumps), general service.
   d. Chemical Plants—volatile liquids, viscous liquids, filter press feed (direct-acting pumps) injection (power pumps).
   e. Hydraulic presses.

2. Diaphragm—Miscellaneous handling of corrosive toxic, abrasive or expensive materials, where packing leakage cannot be tolerated, or packing would not stand up.

Advantages

1. Direct-Acting.
   a. Simple, flexible, reliable, low cost among reciprocators.
   b. Self-contained unit.
   c. Can utilize low-pressure steam (or air). Especially suited to remote locations where steam or air is available but electricity is not available.
   d. Expansion of steam very slight. Pump reduces steam pressure but uses very little of its heat. Therefore, operation is economical if there is process or other use for the exhaust steam.
   e. Easy operation, control and maintenance.
   f. Pressure is proportional to available steam (or air) pressure, therefore no overpressure protection required.
   g. Uniform efficiency over wide range of head, capacity and speed.
   h. Capable of handling high-viscosity materials.

2. Power Pumps.
   a. High efficiency (90 percent and higher at full load).
   b. High pressures, even at small capacities, at high efficiency.
   c. Definite flow pattern—can be used for metering.
   d. Simple and reliable, especially the modern types with automatic self-lubrication, built-in reduction gears, special valve and plunger materials, efficient rod packing, etc.
   e. Will handle high-viscosity fluid, up to 2,500 S.S.U. with little effect on performance, and up to 100,000 S.S.U. at low speeds.
   f. High plunger speeds of 400 ft. per min. and higher.
   g. Smooth, quiet operation.

3. Diaphragm Pumps.
   a. No packing used, therefore no leakage, a most desirable feature when handling toxic, corrosive or expensive materials.
   b. Will handle slurries.
   c. Can be made quite compact.

Disadvantages

1. Large space requirements (except some diaphragm pumps).

2. Limited materials of construction.

3. High "Net Positive Suction Head" requirements.*

4. Not generally suitable for handling liquids containing solids, abrasives, or dirt (except diaphragm pumps).

5. High cost compared to centrifugal pump used for same conditions.

6. Inflexible operating characteristics compared to centrifugal pump.

7. Power pump must be protected from overpressure.

8. Pulsating flow, unless pump has multiple cylinders or special drive mechanism, either of which greatly increases expense.

ROTARY

The second of the two general classes of pumps based on the principle of positive displacement.

Principle

In general, as the rotary member turns, it creates cavities which move from suction to discharge forcing the liquid along.

1. Positive displacement — many variations (see below).

2. Seal between suction and discharge formed by close running clearances or sliding or rolling contact.

Types

1. Gear—external spur, helical or herringbone, internal spur or helical. Figs. 9, 10.

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* "Net Positive Suction Head" is the total suction head determined at the suction nozzle and corrected to datum, less the vapor pressure of the liquid at pumping temperature, both in feet of liquid. "NPSH available" is a characteristic of the pumping system, and varies with fluid flow because of fluid friction. "NPSH required" by a pump is a function of the pump design, and represents the minimum suction head necessary to force liquid into the pump, without cavitation, at a given rate.

2. Lobe—a type of gear having 2, 3, or 4 teeth per gear. Figs. 11, 12.

3. Screw—seal formed by meshing the screw either with a helical stator, or with idler screws, Figs. 14, 18. Not to be confused with the single screw in a cylindrical stator, like a screw conveyor. This type is in a class by itself, working on the principle of viscous drag. It can develop very high pressures on viscous fluids, and is, in fact, used for extruding plastics, etc., at high pressures.

4. Sliding vane. Fig. 13.

5. Swinging vane. Fig. 15.

6. Cam. Fig. 16.

7. Cam and piston. Fig 17.

8. Shuttle-block. Fig. 19.

9. Radial piston.

10. Axial piston—wobble plate or cam-actuated.

11. Rubber tube—"squeegee" action by cam (Fig. 20), rollers, or succession of fingers that squeeze the tube. In the latter variation, the tube is usually straight, but the fingers are actuated by a rotary cam.

Characteristics (Fig. 22)

1. Flow is proportional to speed, except for losses due to:

a. "Slip" (internal leakage from discharge to suction). The slip varies greatly with pressure differential and viscosity.

b. Suction conditions.

(1) Pressure (at the suction connection).

(2) Vapor pressure of the liquid at pumping temperature.

(3) Entrained or dissolved gas.

2. Flow theoretically independent of pressure differential. Actual capacity is affected by increase in slip with pressure.

3. Power varies directly with pressure and speed.

4. Power at constant speed and pressure varies with viscosity.

5. Self-Priming—rotary, positive-displacement pumps are good vapor handlers, therefore self-priming. However, most types should never be operated dry, because the liquid is needed for sealing and lubricating the close clearances. A few types will handle dry gas.

Materials of Construction

1. Most common machinable metals and alloys. There are limitations due to the close clearances and rubbing contacts that are inherent in the designs. If the materials have poor wearing or seizing characteristics, the clearances must be increased, thereby decreasing efficiency and necessitating oversize pumps.

2. Natural and synthetic rubbers. Fig. 21.

3. Teflon. Fig. 16.

4. Nylon. Fig. 16.

5. Phenolic resins and other plastics.

6. Carbon.

The rubbers and plastics have limitations because they swell in some fluids.

Typical Applications

1. Clean, non-abrasive, non-corrosive liquids, in general. (Pumps having resilient members of rubber, such as screw, gear or tube, are the important exception.) Figs. 14, 20, 21.

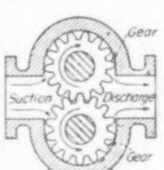
2. For handling wide range of viscosities, from solvents to heavy tars, soaps and greases. Most types can be steam-jacketed to control viscosity or prevent freezing.

3. For pressures up to 1,000 psi. on non-lubricants.

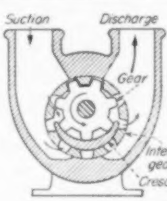
4. For higher pressures on lubricating fluids.

5. For low viscosity, volatile fluids, including entrained gas or vapor.

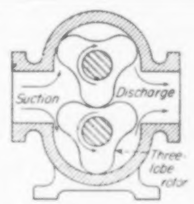
6. Miscellaneous chemicals, oils, gasoline, solvents, ink, tars, greases, soaps, paint, varnish, viscose, molasses,



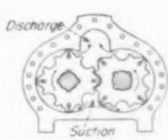
(9) External gear pump



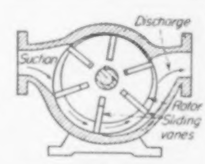
(10) Internal gear pump



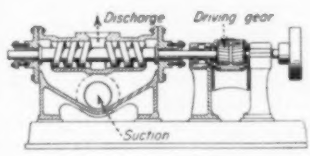
(11) Three-lobe pump



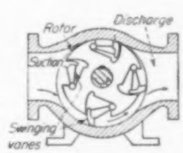
(12) Four-lobe pump



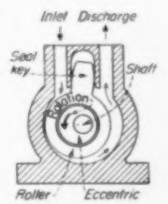
(13) Sliding vane pump



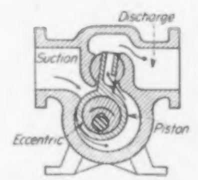
(14) Single screw pump



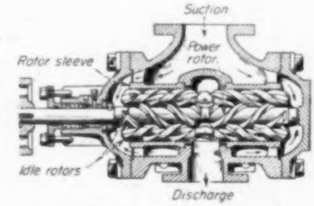
(15) Swinging vane pump



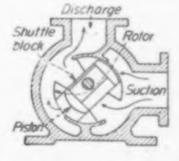
(16) Cam or roller pump



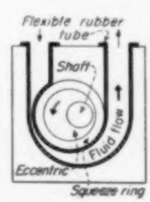
(17) Cam-and-piston pump



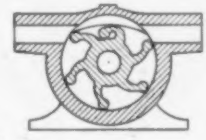
(18) Three-screw pump



(19) Shuttle-block pump



(20) Squeegee pump



(21) Neoprene vane pump

etc. Several types, such as the single screw with rubber stator (Fig. 14) will handle very heavy fluids containing a high percentage of solids, such as fruit cake mix and other food products.

7. For very low flows over wide range of pressure.

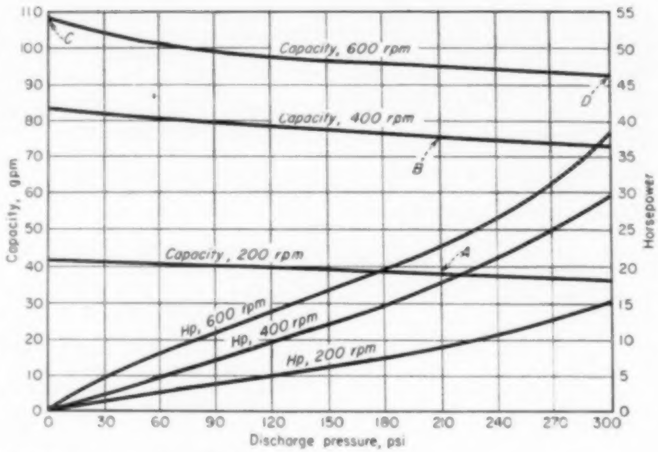
8. Metering.

Advantages

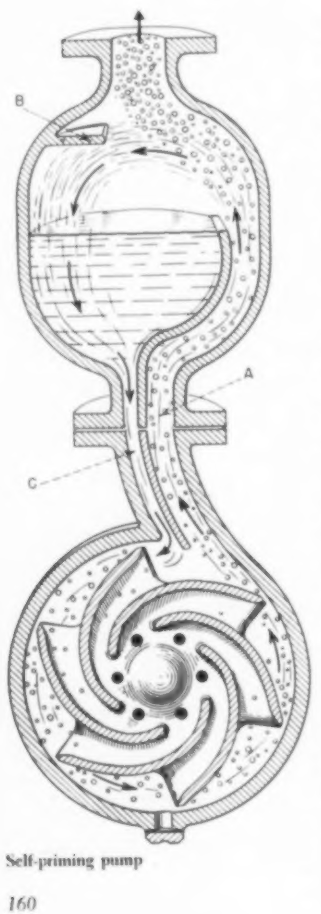
1. Low cost.
2. Small space.
3. Wide range of capacity, head and viscosity.
4. Good vapor-handler.
5. Self-priming.
6. Many types can be run in either direction with equal performance, thus simplifying piping or eliminating other pumps.
7. Many types are very simple, with no valves.

Disadvantages

1. Close clearances and/or rubbing contact limit suitable materials of construction.



(22) Rotary pump characteristics



Self-priming pump

2. Close clearances limit the handling of solids, and require freedom from corrosion.
3. Being positive displacement, these pumps must be protected from overpressure by a suitable relieving device. Many types of pumps have relief-valves built in.
4. Low volumetric efficiency at low speeds (slip approaches displacement). This effect increases directly with the pressure/viscosity ratio.

Centrifugal Pumps

The second broad type of pump to be discussed is the centrifugal, socalled because it imparts velocity to the liquid by centrifugal force, then converts some of the velocity to pressure. Its development is very recent, compared with the reciprocating pump.

The first crude model of a pump based on the principle of centrifugal force was built in the year 1680, but it wasn't until 1818, in the United States, that a practical working model was demonstrated. The first commercial manufacturing began about 1840-1850. Not until about 1890, however, did the centrifugal pump come into common use.

The explanation is simply that the centrifugal pump, by its very nature, requires relatively high rotative speeds, consequently its full development and use had to await the development of suitable prime movers. The introduction of steam turbines, electric motors, and internal combustion engines made the centrifugal pump a practical device. Its growth since has been rapid, until today it has displaced the reciprocating pump in a great variety of applications, and is now probably the most common type.

The great variety of types of centrifugal pumps being built today are commonly classified: Straight Centrifugal (Fig. 23—radial flow impeller); Axial flow (propeller); Mixed flow—Continuous range of types between extremes of straight centrifugal and axial flow pumps; Centrifugal plus jet booster; Regenerative.

STRAIGHT CENTRIFUGAL

Principle

Liquid enters center of rotating impeller, is accelerated to high velocity, and is thrown by the vanes radially outward (imparting pressure by centrifugal action of the vortex) into a passage which converts most of the velocity energy to additional pressure.

Types

1. Method of energy conversion.
   a. Volute, Fig. 24. May be scroll or concentric.
   b. Diffuser or turbine. Fig. 25. (Additional conversion in discharge nozzle—all types).
2. Number of stages. Figs. 30, 32.
3. Impeller type.
   a. Single or double suction, Fig. 30.
   b. Open, Fig. 26, semi-open, Fig. 27; or enclosed, Fig. 28.
   c. Straight, single curvature, or double-curvature vanes.
   d. Non-clog (for pumping solids), Fig. 29 shows one type.
4. Axis of rotation.
   a. Horizontal. Fig. 30.
   b. Vertical. Fig. 35.
   c. Inclined.
5. Casing.

a. Solid or split (horizontally, vertically or diagonally) or double.
b. Orientation of nozzles.
c. Plain or self-priming.
d. "Dry floor" or submerged installation.

6. Drive Method.

a. Direct-connected (any type of rotative power source).
  (1) Cradle-mounted (having own shaft bearings, motor connected by coupling). Fig. 30.
  (2) Close - coupled (impeller mounted directly on motor shaft). Fig. 31.
  (3) "Long vertical shaft," motor above ground (such as deep-well). Fig. 33.
  (4) Submersible motor (deep-well type pump). Fig. 34.
b. Geared.
c. Belt or chain.
d. Integral electric motor (magnetic or induction drive through pumped liquid or oil blanket). Fig. 36.

Characteristics (Figs. 37, 38)

1. Capacity varies directly, the head as the square, and the horsepower as the cube of either the speed or diameter of the impeller, the other being constant.
2. Delivers any capacity from zero to maximum at constant speed along its curve.
3. Head, power and efficiency all are functions of capacity.
4. Flow adjusts itself automatically to head fluctuations.
5. The head, and therefore the power, are definitely limited, consequently the pump is safe from overpressure, and the drive is safe from overload.
6. Will handle only small proportion of vapor before losing prime, or vapor binding. Therefore, not self-priming in itself, but can be made so by addition of suction priming chamber and discharge air separator, and special volute design. See cut on opposite page.

Size Range

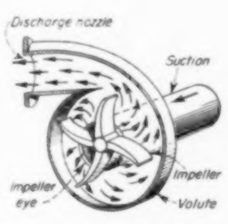
1. ¾ in. pipe size to 14 ft. openings.
2. 1 gal. per min. to 720,000 gal. per min. (Grand Coulee pumps).
3. Heads up to 2,000 psi. in one casing are most common, a few higher.
4. Up to 50 or more stages in one casing. Three 8-stage pumps in series have been used to develop a total pressure of about 5,300 psi. Deep-well pumps have many bowls stacked. With submerged motors (Fig. 34) they have been built with as many as 317 stages. Deep-well pumps may be straight centrifugal or mixed flow, long shaft from motor above ground or submerged.
5. Horsepower—1/15 to 2,000 in common use. The largest pump drivers ever built are the 65,000 hp. vertical electric motors required for the Grand Coulee pumps. The suction openings of each pump are 14 ft. in diameter, the discharge openings 12 ft. The impellers are 14 ft. in diameter and weigh 30 tons each.

Materials of Construction

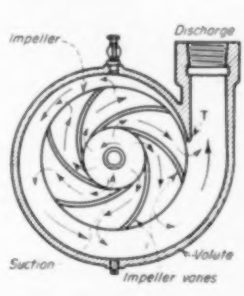
1. All machinable metals and alloys.
2. High-silicon irons (machinable only by grinding). Fig. 51.
3. Carbon.
4. Plastics (phenolic, furane, acrylic resins, etc., solid or lined).
5. Glass.
6. Porcelain. Fig. 53. Hard rubber of similar construction.
7. Natural and synthetic rubber. Fig. 55.

Typical Applications

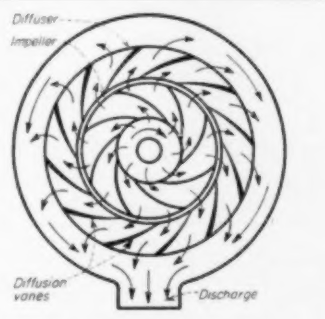
1. General service, Fig. 30, water, chemical, oil, etc., flood, fire, irrigation, water supply. Heads normally up to 200 ft. or so per stage, capacities virtually unlimited. Higher heads per stage practical at very high capacities.
2. Refinery and chemical process—hot oils (Figs. 54, 56), hot and/or corrosive chemicals, etc. Figs. 51, 52, 53, 55.
3. Handling liquids containing solids, abrasives, etc. (sewage, sand, slurries, suspensions, miscellaneous food products, soap, whole fruit, live



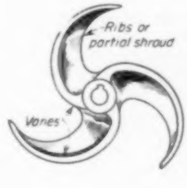
(23) Principle of centrifugal pump



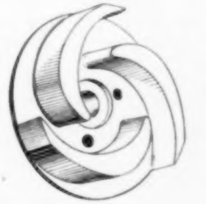
(24) Radial section through volute-type pump

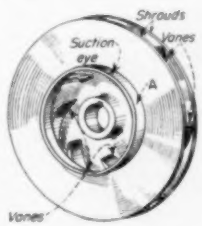


(25) Radial section through diffuser-type pump

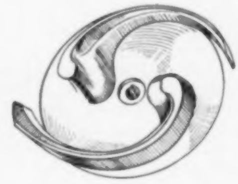


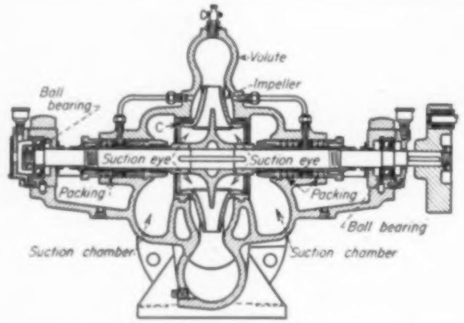
(26) Open impeller


(27) Semi-enclosed impeller

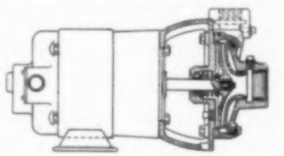


(28) Closed impeller

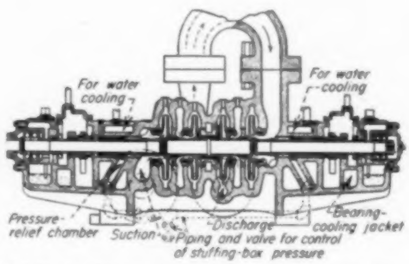

(29) Non-clog impeller



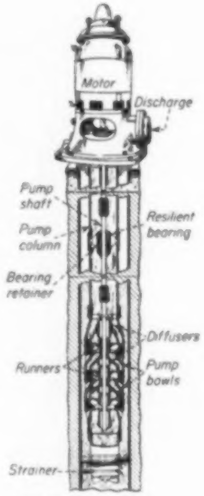
(30) Single-stage double-suction, split case centrifugal pump



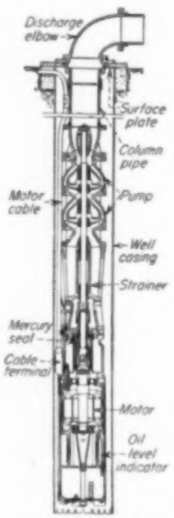
(31) Close-coupled water pump



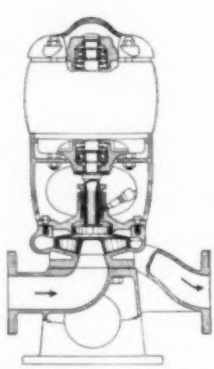
(32) Four-stage pump with opposed impellers



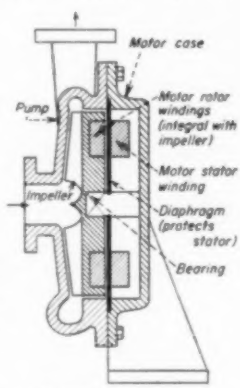
(33) Turbine-type deep well pump



(34) Submersible motor deep well pump



(35) Close-coupled vertical turret-type pump



(36) Pump with integral motor

fish, paper stock, etc.), Fig. 29. Non-clog impeller. Stock pump with large openings, and replaceable wear plates.

4. Sanitary service (for foods, medicines, etc.)—non-contaminating to fluid handled, special construction for easy dismantling and cleaning.

5. High heads—easily obtained by staging, if capacity, and/or operating requirements justify the expensive construction. Figs. 32, 33.

6. Well pumping—multi-stage turbine, Fig. 33, or jet, Fig. 47 (water, brine, mine dewatering, etc.). May be straight centrifugal or mixed flow; long shaft from motor above ground, or submerged motor. The modern deepwell pump is indeed a far cry from early Egyptian pumps like Joseph's Well.

7. Boiler feed. Fig. 32 shows a typical construction.

8. Hydraulic pressure-steel descaling, press operation, elevators, etc.

9. Submerged service (sump, tank, etc.).

10. Miscellaneous applications requiring self-priming (often portable)—construction or flood dewatering, fire, irrigation, sump, top-unloading of tanks and tank cars, etc.

11. Ideal for any service where it is desirable to control capacity automatically by throttling in order to maintain liquid level or other process variable.

12. Petroleum pipeline service.

Advantages

1. Simple construction—one moving part—the rotor.

2. Low cost.

3. Small space requirement.

4. No close clearances, therefore, can handle liquids containing dirt, abrasives, large solids, etc.

5. Low maintenance—no close clearances to be maintained. Can tolerate considerable corrosion and erosion before performance is affected seriously.

6. Quiet operation.

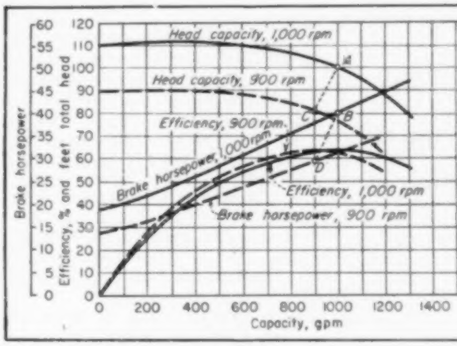
7. Dependable service.

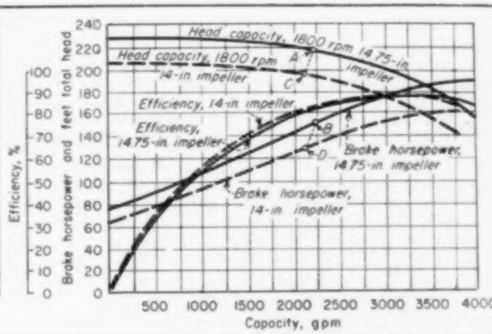
8. Low NPSH (net positive suction head) requirements.

9. Utilizes high speed motor, engine or turbine drives (small space, low cost).

10. Can be built of wide variety of materials.

11. Can be built in wide range of sizes.





(37) Centrifugal pump characteristics vs. speed

(38) Centrifugal pump characteristics vs. impeller diameter

12. Can be built in wide range of operating characteristics.

13. Flexible operating characteristics. Figs. 37, 38.

a. Capacity adjusts automatically to changes in head. This property can be utilized to control capacity over wide range at constant speed.

b. Pressure and power are limited, therefore safe.

Disadvantages

1. Pressure limitations—(See "Size and Range" above).

2. Viscosity limitations—effects on head, capacity and efficiency appreciable at 200 S.S.U., serious at 500 S.S.U. and increases rapidly with increasing viscosities, Fig. 39.

3. Unstable at low flow (near "shut-off").

MIXED AND AXIAL FLOW

These two types are somewhat similar in characteristics, sizes and application and will therefore be discussed together.

Principle

1. Axial Flow, or Propeller—Fig. 40. Flow parallel to the axis. Head is generated by vortex action and propelling or lifting action of the vanes. Velocity energy conversion by averaging velocity and by reducing velocity by means of diffusion vanes and/or increasing diameter of discharge.

2. Mixed Flow—A compromise, combining some axial flow with some radial flow. Head generated by combination of radial (centrifugal) velocity, vortex, and axial lift of vanes, plus velocity energy conversion in a volute or diffuser section. Fig. 43.

Types

1. Vertical or horizontal.

2. Axial (pipe or diffuser casing), Figs. 40, 42; or Mixed Flow (volute or diffuser casing) Figs. 41, 43.

3. Conversion—plain, diffuser, or volute.

4. Number of stages.

Characteristics

Since axial flow, mixed flow and straight radial centrifugal pumps operate on similar principles, their characteristics are similar in many ways (see "Characteristics" of Centrifugal Pumps). The main difference lies in the head developed per stage (at maximum efficiency); the radial generates the highest head, axial the lowest, for a given impeller size and speed. There is a continuous range of types between the extremes. Axial flow pump head and power curves rise sharply toward shut-off in contrast to the falling power curve and rather flat head curve of the straight centrifugal, Fig. 44. Curves for mixed-flow pumps are intermediate. The shape of the characteristic curve is a function of a value called "specific speed," used by designers to define the impeller type. Specific speeds range from high for axial to low for radial.

Size

1. Capacities—high, commonly to about 100,000 gpm.

2. Heads—low, up to about 40 ft. for axial, 100 ft. per stage for mixed flow.

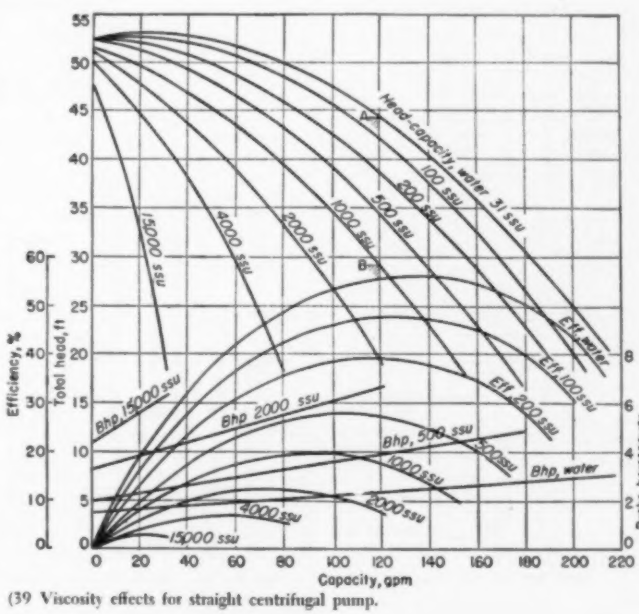
3. Openings—up to 60 in.

Typical Applications

Any high capacity, low head service:

1. Irrigation.

2. Flood control.



(39 Viscosity effects for straight centrifugal pump.

3. Industrial cooling water river pumps.

4. Cooling or heating water and process circulating. Figs. 40, 42, single stage.

5. Construction dewatering.

6. Deep-well turbine (vertical mixed-flow multi-stage).

Materials of Construction

Because of their usually large size and application, these pumps are rarely built of any materials other than cast iron, fabricated steel and bronze. Some have been rubber or neoprene-lined for corrosive water service, and some smaller sizes have been built of stainless-steel and nickel. They could be built of any machinable alloy if the application justified it.

Advantages

(See "Advantages" under Straight Centrifugal Pumps, above.)

Axial flow can have adjustable vanes for control.

Disadvantages

Axial flow power curve rises sharply towards shut-off.

CENTRIFUGAL-JET (Fig. 45)

Principle

An ordinary centrifugal pump (single or multi-stage), with a jet pump (ejector) booster in series. The centrifugal pump supplies the pressure and flow of liquid for the operation of the jet.

Types

1. Horizontal or vertical (at ground level).

2a. Shallow well (jet above ground, often built into the centrifugal pump casting)—lifts to 25 ft. Fig. 46.

2b. Deep well (jet located in the well, below the water surface)—lifts to 120-125 ft. are most common, but special pumps are built for lifts of 250 ft. with single stage centrifugal, Fig. 47, and higher with multi-stage centrifugal pumps.

Characteristics

1. Low capacity – 5-20 gpm. are most common, some to 80 gpm.

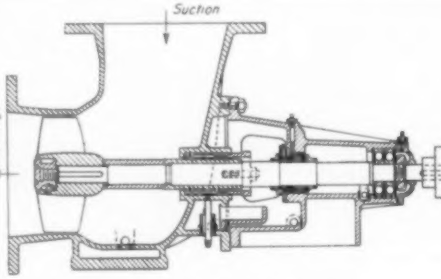
2. High head—30-120 psi.

3. Comparatively low lifts for well pumps – to 125 ft. most common (much higher than straight centrifugal).

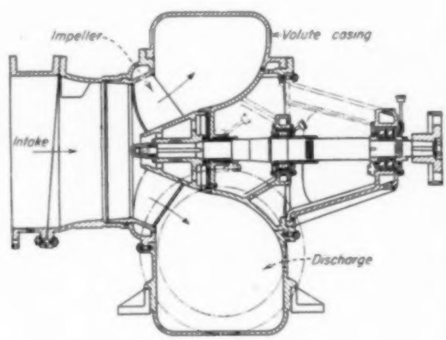
4. Shallow-well type is made self-priming, Fig. 46.

5. Horsepower curve is non-overloading (practically flat).

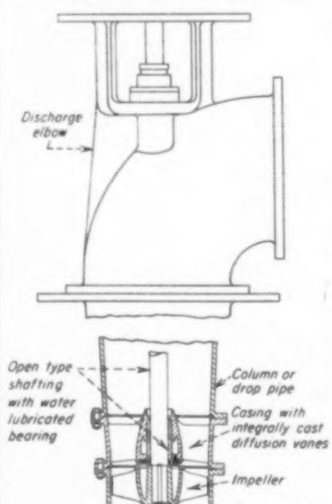
6. Peak efficiency is lower than that of straight centrifugal, but efficiency at the operating point is often higher than that of a centrifugal pump at the same point.



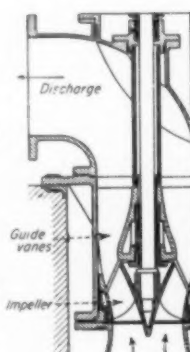
(40) Horizontal propeller pump



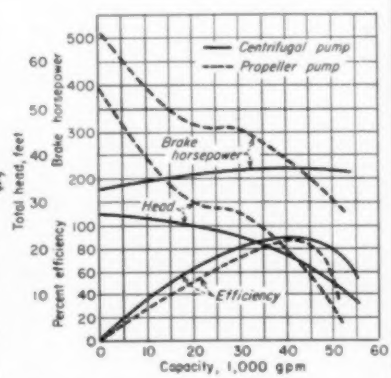
(41) Mixed flow volute pump



(42) Vertical diffuser pump, axial-flow



(43) Vertical diffuser pump, mixed-flow



(44) Characteristics of propeller vs. centrifugal pump

Size

Standard models up to 2 hp. are most common, but special models are built up to 20 hp.

Materials of Construction

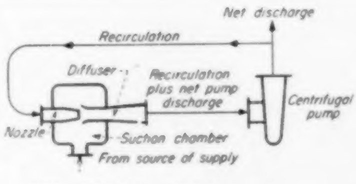
Because of their applications (see below) standard construction is limited to cast-iron with bronze impeller, shaft, jet and fittings. These pumps could, however, be built in a wide variety of other materials if demand existed.

Typical Applications

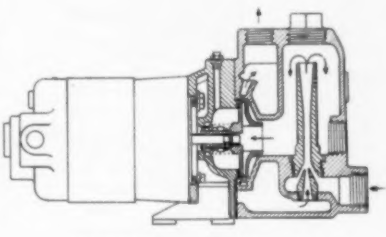
1. Domestic or light industrial water supply—from wells or rivers (the predominant use). Fig. 46.
2. Water sampling from rivers.

Advantages

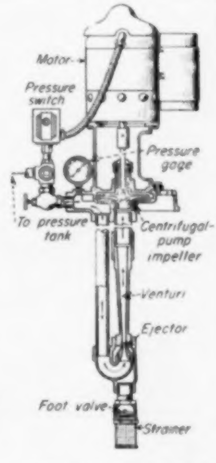
1. Simple construction – only one moving part—the centrifugal rotor. No moving parts in the well (even the jet is above ground in the shallow-well type). The pump and motor can actually be placed at a convenient place away from the well. (The deep-well type requires, and the shallow-well type is improved by, a foot-valve at the bottom of the column under water to hold water in the column when the pump is not operating. These valves, however, operate over long periods with little or no trouble.)
2. No close clearances.
3. Much higher suction lift than centrifugal pump alone.
4. Non - overloading horsepower curve.
5. Smooth, non-pulsating flow.
6. Steep head-capacity curve, with head about 50 percent higher than that of the centrifugal pump alone.



(45) Principle of jet pump



(46) Shallow-well jet pump



(47) Deep-well jet pump

REGENERATIVE PUMP

Also called "Regenerative Turbine," "Turbine Vane," "Vortex," or "Peripheral."

Principle

Multipass or multistage centrifugal, plus semi-positive displacement. As seen in Fig. 49, the impeller has many small vanes cut into both sides of its rim. The vaned rim rotates in an annular channel which is interrupted by a barrier between suction and discharge. The liquid enters the channel on both sides of the impeller at one point in the periphery and flows into the impeller cavities between vanes.

The rotating vanes impart velocity to the liquid by centrifugal action, throwing it out into the annular channel. This channel is so shaped as gradually to reduce the velocity, thus increasing the pressure energy, then direct the liquid back between the vanes, in a continuous circular spiral path.

More pressure is added in each pass, hence the name, "regenerative." The liquid re-enters the impeller and picks up additional pressure numerous times during its travel once around the pump casing, which explains how this type pump develops very high heads, at low flows. It is, in reality, multi-stage.

When the liquid has traveled around the periphery of the casing once, it reaches the barrier, or stripper, through which the impeller passes with close clearance, and passes out the discharge port.

Close clearances play an important part in the operation of this type pump, and the vanes, in moving rapidly in the small annular chamber which ends at the stripper have a semi-positive displacement feature. Therefore, this pump will handle vapor as well as liquid as long as there is sufficient liquid to seal the close clearances, and is, consequently, self-priming.

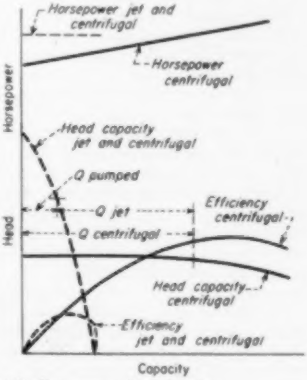
Types

1. Through shaft, or overhung shaft.
2. Close-coupled (overhung shaft only), or cradle-mounted with separate motor.
3. Single or two-stage.

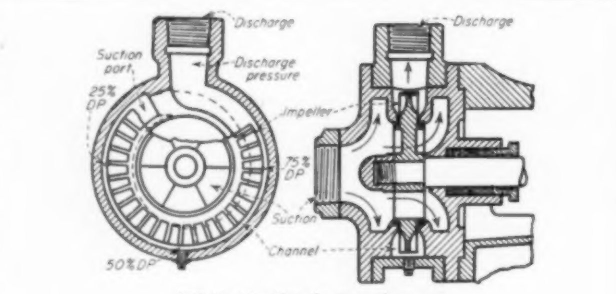
Characteristics (Fig. 50)

Follow many of the same laws, including head-capacity-speed-impeller diameter laws, as the plain centrifugal pump, namely:

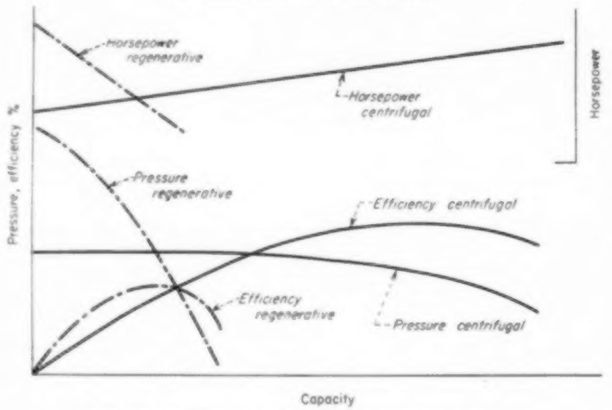
1. Capacity varies directly, head as the square, and horsepower as the cube of either the speed or diameter of the impeller, the other being constant.
2. Delivers any capacity from zero to maximum at constant speed. (However, these pumps must not be operated too close to "shut-off", that is closed discharge or zero flow, because pressure and horsepower rise sharply to a maximum at shut-off, and consequently overheating and erosion will cause a mechanical breakdown of the pump within a comparatively short period of time.
3. Head, power and efficiency all are functions of capacity.
   a. Efficiency drops off rapidly at low capacities, much more so than for a straight centrifugal.
   b. Flow adjusts itself automatically to head fluctuations. However, the head-capacity curve is much steeper than for a centrifugal pump, that is, the capacity change is small over a wide range in



(48) Jet pump characteristics



(49) Construction of regenerative pump



(50) Characteristics of centrifugal vs. regenerative pumps

head. This is a result of the semi-positive displacement feature.

c. The head and therefore the power are definitely limited. However, they differ from the straight centrifugal in that both curves are so steep, rising sharply to maximums at shut-off, usually two to four times the values at maximum efficiency. (Therefore, these pumps should always be operated with relief valves or other protection to reduce motor horsepower requirement and overpressure.)

4. Good vapor-handler, therefore inherently self-priming. However, these pumps should never be run dry. If to be operated as self-primers, they should have a suction trap to keep sufficient liquid in the pump at all times to provide for sealing and lubricating the close clearances.

Size and Range

1. Usually low capacity—1 to 50 gpm., most common. (They have been built for capacities to 200 gpm., with several impellers in parallel.)

2. High head—up to 500 ft. are most common, though heads up to about 1,200 ft. are available, usually with several impellers or pumps in series.

3. Viscosities to about 400 S.S.U.

Materials of Construction

1. Cast iron casing, steel- or bronze-fitted.

2. Cast steel, bronze-fitted.

3. All bronze.

4. Stainless steel. It can be, and occasionally is, used but is not popular because the tendency to seize necessitates increased clearances, which decreases efficiency and requires oversized pump.

Application

1. General low-capacity, high-head service, handling clean liquids which are not corrosive to the materials of construction—water, oils, miscellaneous chemicals, volatile liquids.

2. Small boiler feed.

3. Condensate return.

4. Water supply.

Advantages

1. High head per stage even in very small, inexpensive sizes, so ideal for low capacity in range where a centrifugal would be too close to "shut-off."

2. Little change in capacity over wide range of head.

3. Good vapor handler, so self-priming.

4. Small space requirements compared to any other pump that could be used.

5. Low cost compared to any other type for same conditions.

Disadvantages

1. Materials of construction limited, because of close clearances and fragile impeller vanes, to those which are tough, non-corroding in the service, resistant to seizure and dimensionally stable.

2. Can successfully handle only clean, non-abrasive, non-corroding liquids, viscosity of 400 S.S.U. maximum, and which do not leave residue or deposits.

3. Close clearances call for very careful assembly and elimination of pipe strains that would cause misalignment and binding of the rotor.

4. Limited life—3 to 4 years under ideal conditions (clean, non-corrosive service)—before clearances must be restored. This is, at best, one-third to one-quarter the life of a centrifugal pump in the same service. Therefore, maintenance costs are higher, and more spare units should be provided for regenerative pumps when continuity of operation is required.

Centrifugal Chemical Pumps

All types of pumps have their definite limitations. Many of these limitations are particularly to be avoided in modern chemical plant service because of the severe demands that we make on pumping equipment.

These demands include continuous heavy duty for long periods with freedom from forced shut-downs, flexible operating characteristics, ease of control, availability in wide choice of materials of construction to meet variety of corrosion, wide range of operating conditions (head, capacity, temperature, viscosity, etc.) maximum interchangeability of pumps and parts, handling of solids and abrasives in suspension, and a design that can tolerate some erosion and corrosion. The centrifugal pump satisfies these demands to a greater extent than any other pump.

For this reason it is now the most widely used of all types in chemical service. However, even the standard

time-honored centrifugal pump designs, which were developed primarily for water service, have serious limitations for chemical service; consequently, there has been developed a specialized type commonly known as the "chemical pump."

Let us first summarize the principal limitations of other specific types of pumps including standard centrifugal pumps, as applied to chemical service, then describe the advantages of the modern "chemical pump."

Limitations of Various Types

1. Reciprocating Pumps:
   - a. Expensive, compared to centrifugal, within range of centrifugal.
   - b. Design is very costly to construct in special alloys. Fig. 5. Existing designs and patterns not adapted to alloys, therefore alloy pumps are not standard. They can be obtained, if at all, only on special order with long delivery. Replacement parts hard to obtain.
   - c. Rubbing contact and danger of seizure limit choice of materials.
   - d. Many moving parts, high maintenance costs.
   - e. Large space requirements.
   - f. Comparatively low capacity.
   - g. Pulsating flow.
   - h. High NPSH requirement compared with centrifugal.
   - i. Not generally suitable for dirt or abrasive-laden liquids.
   - j. Relatively inflexible operating characteristics.
   - k. Most types require protection against overpressure and power overload.
   - l. Reciprocating rod more difficult to seal against leakage than rotary shaft.
2. Rotary Pumps and Regenerative Pumps:
   - a. Limited materials of construction, because rubbing contact and close clearances create danger of seizure, and many parts such as gears and vanes are difficult or impossible to produce in some alloys. Most types cannot tolerate any corrosion at all, because of close clearances and rubbing contact.
   - b. Limited range of characteristics.
   - c. Both types require protection against overpressure and power overload.
   - d. Not generally suitable for handling dirt- or abrasive-laden liquids.
3. Horizontally-Split Centrifugal Pumps:
   - a. Material limitations: Heavy castings too expensive if built of high alloys; castings too intricate to be poured of some alloys, Fig. 30; most existing designs and patterns not adapted to high alloys, therefore alloy construction not standard, only special order and long delivery.
   - b. The typical construction is usually more expensive to build, and to maintain.
   - c. Large gasket areas, necessity of gasketed T-joint at stuffing boxes, and two stuffing boxes mean more area subject to leakage.
4. Close-Coupled Centrifugal Pumps (impeller mounted directly on motor shaft, pump supported from motor frame). Fig. 31.
   - a. Congested, hard to maintain.
   - b. The necessary long-shaft motors are special, and not generally available with alloy shafts.
   - c. Pump outage means motor outage, and vice versa, thus tying up good as well as faulty equipment.
   - d. Motor more subject to damage from leaking fluid or vapors.
   - e. Motor size or speed not easily changed, as often required as a result of changes in chemical process.
   - f. Often have threaded suction and discharge connections which leak.
5. Cradle-Mounted Centrifugal "Water" Pumps (common designs, end-suction, vertically-split casing, coupled to separate standard motor or other driver).
   - a. Competitive, low-cost cramped design with minimum features. No provision for special features often designed for chemical service (such as water-cooled stuffing box, water-cooled bearings, extra-deep stuffing box, leak collection, heavy-duty bearings, etc.).
   - b. Usually have no replaceable shaft sleeve. Some have combination sleeve and impeller, which limits choice of material and replacement.
   - c. Threaded connections (subject to leakage and corrosion).
   - d. Inadequate bearing protection.

Advantages

Not all manufacturers have adopted all features, but these are typical. Figs. 51, 52, 54. These features apply mainly to the all-metal chemical pumps, although many apply as well to the non-metallic pumps, such as hard or soft rubber, glass, stoneware, etc. The non-metallic pumps, however, usually have some special features inherent in their construction because of the material. Figs. 53, 55.

1. All the advantages of the standard centrifugal pump (discussed previously), *plus* the following improvements on the standard centrifugal pump design:

2. Deep stuffing box, with provision for liquid-sealing and water-cooling when required by process demands.

3. Plenty of room for mechanical seal. The importance of a good shaft seal or packing (items 2 and 3) cannot be over emphasized. Leakage of many chemicals may be expensive, dangerous or just plain messy. Many chemical pumps are satisfactory in every respect except the shaft seal.

4. Rugged construction of casing, bearings, and shaft. In addition to achieving reliability, this permits operation over wider range of the curve without overstressing due to hydraulic forces, thus further contributing to operating flexibility.

5. Provision for water-cooling of bearings when required.

6. Extra erosion-corrosion allowance for longer life.

7. External bolting often used on casings to permit use of alloys that are difficult to machine, or machinable only by grinding.

8. Simplified castings and other parts to widen the field of suitable materials. For example, vertically-split casings.

9. Many have impeller nut integral with impeller, thus eliminating one leakage path and reducing susceptibility to corrosion damage.

10. Some have a solid corrosion-resistant shaft at the pump end, separable from the portion in the bearing bracket. This eliminates the shaft sleeve with its potential leakage path and corrosion under the sleeve, and facilitates field maintenance.

11. Maximum interchangeability of pumps and parts, through simplification and standardization in design, and by increasing the operating range of each size at some sacrifice in efficiency, thus decreasing the number of sizes required for a given plant (see item 16).

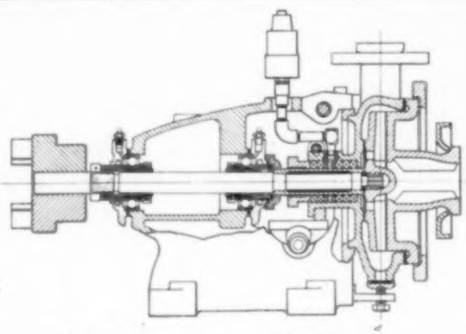
12. Flanged connections, and elimination of drains and vents to reduce corrosion (of threads, and at sharp corners) and leakage. Many chemical pumps are designed with self-venting casings in order to eliminate separate vent holes. This is a most desirable feature.

13. Easy adjustment of impeller clearance in casing.

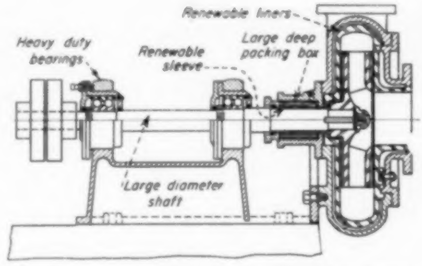
14. Means of collecting leakage, and protection of bearing housing, bearings and base plates from corrosion.

15. Available with either open, semi-enclosed or closed impellers for different conditions.

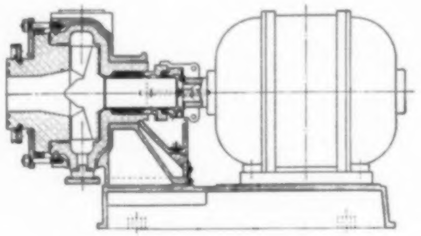
16. Several manufacturers build self-priming, as well as regular, centrifugal chemical pumps. Some of them also have incorporated maximum interchangeability of parts and pumps and maximum flexibility of application through the use of the



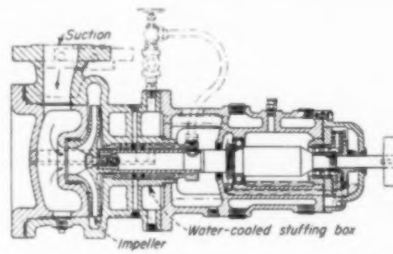
(51) High-silicon iron centrifugal pump



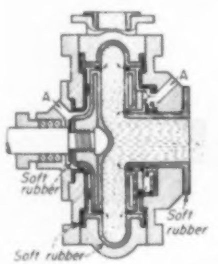
(52) Slurry pump lined with wear-resistant metal



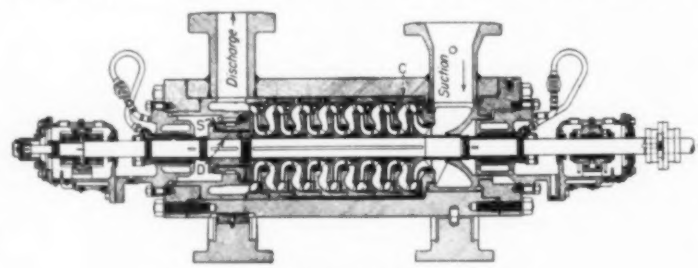
(53) Chemical stoneware pump



(54) Stainless steel pump for hot liquids



(55) Rubber-lined sand pump



(56) Seven-stage diffuser type hot oil pump

same casing and impeller for self-priming as for regular pumps by the addition of a trap and an air separator.

17. Submerged pumps sometimes used to eliminate packing in severe services.

A great variety of pumps can be, and are being built covering an extremely broad range of conditions. The chances are excellent that a pump is already available, or can be built, to solve your pumping problem.

But, you, the process engineer, may well ask, "How do I go about obtaining a pump for my job? What basic data must I collect in order to provide the pump specialist with a sound foundation on which to base his selections?" I would include the following:

Basis for Selection of Pumps for a Chemical Plant

INFORMATION REQUIRED

For Selecting Basic Type

1. Capacity and Head:
   a. Maximum for each.
   b. Permissible or desirable range for each.
   c. Possible future change in requirements.
2. Desirable Operating Characteristics:
   a. Constant head and capacity, or
   b. Variable capacity and nearly constant head, or
   c. Variable head with some variation in capacity, or
   d. Constant capacity against variable head, etc.

Some of these may call for variable speed, throttling, or by-passing. Manual or automatic? These factors influence selection of drive. See item 8 below.

3. Nature of the Liquid—Is it volatile? Lubricating? Corrosive? Unstable? Effect of temperature, pressure, shear rates, time, etc., on its properties. (The name of the liquid may be helpful in pump selection, but is not essential in itself if complete data are furnished.)

4. Nature and Size of Solids in Suspension.

5. Corrosion Data—Suitable materials of construction.

6. Range of Operating Temperature —Possible crystallization, solidification? Expansion problems? Temperature may also influence materials of construction.

7. Viscosity Range—(affects suction flow, slip, horsepower, etc).

8. Type of Power or Prime Mover available or allowable (see item 3 above). Plant steam balance should be considered. Is there need for emergency standby equipment of special type, with special drives in case of electric power failure?

9. Load Factor

After selecting the basic type of pump on the basis of such data, additional data are necessary for an intelligent specific selection.

For Selecting Specific Pump & Drive

Further details about the above items, plus:

1. Specific gravity—affects head and horsepower.

2. Vapor Pressure—consider dissolved or entrained gases also.

3. Suction Conditions—NPSH available and required. This is very important, and is too frequently overlooked. A centrifugal pump is not a good gas compressor. Is there entrained gas or vapor or danger of boiling at the pump? If there is, and it is unavoidable, then the pump must be oversized. Power should be provided for 100 percent liquid. Determine range of suction pressure, and system friction.

4. Discharge Conditions — system characteristics, including friction.

5. Maximum Future Conditions:

a. Head and capacity.
b. Check NPSH, available and required, and horsepower, at the future condition.
c. Consider providing a baseplate for larger motor in the future, if required.

6. Solids in Suspension:

a. Allowance must be made for effect of solids on head when percent solids is appreciable.
b. If the solids are abrasive, the pump can be selected oversize to reduce velocities—longer life may justify this economically.
c. Best impeller type (open, semi-enclosed, closed, non-clog, crusher type, etc.) depends on nature and amount of solids.
d. Select material to resist abrasion, if possible.
e. Sometimes advisable to use cheap pumps for abrasive service, and discard rather than repair them when worn.

7. Corrosion:

a. Availability of pumps of acceptable material may limit, or decide, selection.
b. If corrosion is unavoidable, pump can, in some cases, be selected oversize with reserve performance which will compensate for reduction in performance due to corrosion.
c. Open or semi-enclosed impeller is usually preferred for corrosive service, because corrosion is easier to see and evaluate, easier to repair, and has less effect on performance than in the closed impeller.
d. As in abrasive service, it is sometimes more economical to use a cheap pump and discard it when corroded, rather than repair it.
e. Is there a problem of product contamination by certain materials of construction?

8. Power Available:

a. If steam is available, what are its conditions?
b. If electricity is available, what are its characteristics? Frequency is very important because it determines motor speed, which determines pump performance in the case of direct drive.
c. If neither steam nor electricity is available, what other power source is most practical and economical? (Gas, gasoline, wind, water, oil, etc.)

9. Space Available and Transportation Limitations—These may dictate whether unit should be horizontal or vertical, and limit weight size, or shape of unit or sub-assemblies.

10. Design Details—Are they acceptable to the users—Engineering, Production and Maintenance people? Changes can be negotiated in some cases.

a. General ruggedness.
b. Stuffing box arrangement. Mechanical seal.
c. Bearings, bearing seals, lubrication.
d. Ease of maintenance, alignment.
e. Flanged connections of proper ratings. Threaded wetted parts of any kind should be avoided whenever possible in any type of chemical service.
f. Adequate pressure and performance testing.
g. Maximum interchangeability of parts, minimum number of different sizes (including purchased parts such as couplings, oilers, bearings, etc.).
h. Maximum interchangeability, wherever possible and practical, of new pumps with existing pumps and parts.
i. Maximum flexibility of operation characteristics for interchangeability and future changes in process or use.
j. Is "sanitary" construction, Fig. 56, required?

11. Manufacturer—These things are all important to the final product and the success of the job. Weigh them carefully:

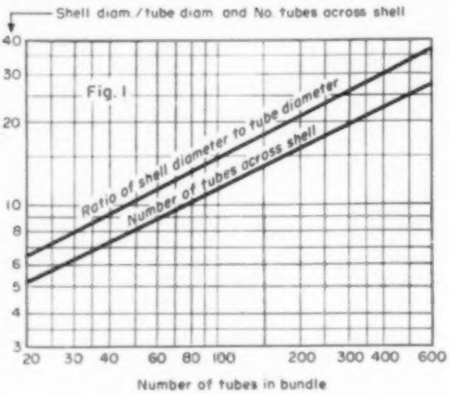
a. General facilities — engineering, foundry, manufacturing, test.
b. Experience—with the design, materials of construction, and any unusual or difficult service conditions.
c. Field service — engineering, replacement parts. This can be of paramount importance in case of trouble in the field, and obviously is worth money. Don't underestimate its value.
d. Workmanship — especially when close clearance and/or special materials, or unusual designs are involved.
e. Engineering cooperation during the design phase—very important, can contribute greatly to the success of the whole job.
f. Ability and willingness to accept necessary change in design or specifications.

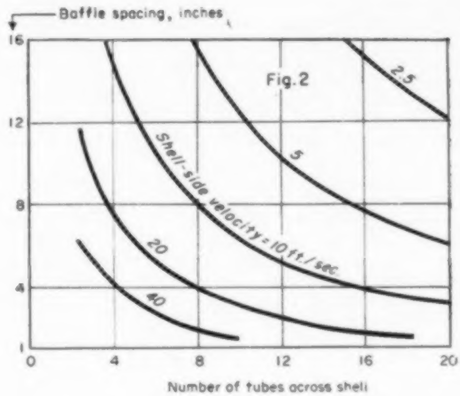
12. Price and Delivery—Both are very important, of course, but are sometimes overemphasized. If the pump with the lowest price or best delivery fails in service, money is thrown away and the job delayed. Good performance is cheapest in the long run. One repair job, or start-up difficulties, with an inadequate pump, may well change it from the lowest *price* and best delivery to the highest *cost* and longest delivery. Also, beware of extra charges which may alter the competitive pattern (after an order is placed).

Conclusion

A great many factors are involved in the performance of pumping equipment, and they should all be considered in the selection of pumps for chemical plants. Modern chemical processes, with their severe demands and competition continually call for the best possible performance, and often, the highest standards.

Pump selection is rapidly becoming more specialized and more important. In many cases the pump application engineer does not get, or cannot get, from the process engineer, data sufficient to make the best possible selection. More complete information will permit better selections, resulting not only in better performance but also longer life, lower operating and maintenance costs, and increased interchangeability with consequent further lowering of maintenance costs.





Quick Estimation Method for Heat Exchanger Dimensions

G. F. Davies, *Process Engineer, Dominion Tar & Chemical Co. Ltd., Montreal, Canada.*

★ January Contest Prize Winner

Engineers making preliminary process evaluations often need to know the approximate physical dimensions of the heat exchangers required. The following method has been found convenient for quickly estimating the size of a typical shell-and-tube exchanger:

1. Estimate the over-all heat-transfer coefficient for the conditions involved. A previous article (*Chem. Eng.*, Aug. 1951, pp. 122-4) offers some suggestions along this line.

2. From process data, determine the exchanger duty and mean temperature difference, then calculate the tube surface required.

3. Select a tube-side velocity (or use the velocity assumed in estimating the coefficient) and calculate the total free cross section for the tubes.

4. From the table, find the number of tubes required for 1 sq. ft. of cross section; use this figure to calculate the number of tubes in the bundle. Assume ¾-in. tubes for a start if you are in doubt as to the tube size.

5. Again from the table, find the surface area contained in 1 sq. ft. of cross section per ft. of bundle length. Use this figure to calculate the length of the bundle which will give the required surface area for the cross-sectional area determined in Step (3). Standard tube lengths of, say, 10 to 16 ft. are usually preferred.

6. From the upper curve of Fig. 1 determine the ratio of shell diameter to tube diameter and from this calculate the shell diameter. (This chart is based on triangular arrangement with clearance between tubes equal to one-quarter of the tube diameter.)

7. From the lower curve of Fig. 1 determine the number of tubes across the shell. Use this number with Fig. 2 to determine the baffle spacing which will give the desired shell-side velocity. (Fig. 2 is based on a flow of 1.0 cu. ft. per sec. and 1-in. tubes. Methods of correction are given below.)

ILLUSTRATIVE EXAMPLE

Suppose we want an idea of the size of the shell-and-tube exchanger needed to cool 20,000 lb. per hr. of an organic liquid from 150 to 100 deg. F., using water entering at 70 deg. and leaving at 73 deg. F. The water will be inside the tubes. Density of the organic liquid is 55 lb. per cu. ft. and specific heat is 0.5.

Heat-transfer load is $(20{,}000)(0.5)(150-100) = 500{,}000$ Btu. per hr. Log-mean temperature difference between the two fluids is 50 deg. F. Assuming an over-all coefficient of 60, the required surface will be $500{,}000/(50)(60) = 167$ sq. ft.

For a 3-deg. F. temperature rise, water flow must be

★ February Contest Prize Winner

"Chemical Method Removes Rust for Weld Repair of Eroded Pump Casings."

A prize of $50 in cash will be awarded to Paul F. Krystow, Materials of Engineering Div., Research & Development Dept., Colgate-Palmolive-Peet Co., Jersey City, N. J. The article will appear in May.

$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. Each month's winner will be announced the following month and published the second following month.

$100 ANNUAL PRIZE—At the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article, which will then be awarded an additional $100 prize.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Articles which are acceptable but are not winners will be published at regular space rates ($10 minimum).

Articles may deal with plant or production "kinks," or novel means of presenting useful data, which will interest chemical engineers. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y.

500,000/(1.0)(3) = 167,000 lb. per hr., or 167,000/(62.3)(3,600) = 0.74 cu. ft. per sec. Assuming a linear velocity inside the tubes of 4 ft. per sec., the tube cross section required is 0.74/4 = 0.185 sq. ft. This is a relatively small cross section, so ⅝-in. tubes would be better than ¾-in.

The number of ⅝-in. tubes required for 1 sq. ft. of cross section is 746. For 0.185 sq. ft. cross section, the number of tubes will be (746)(0.185) = 138.

The external surface area contained in 1 sq. ft. of cross section for ⅝-in. tubes is 122 sq. ft. per ft. of length. The length of tube bundle required for 167 sq. ft. of surface with a cross section of 0.185 sq. ft. would be 167/(122)(0.185) = 7.4 ft.

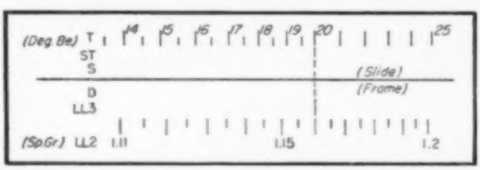
From Fig. 1, the number of tubes across the shell for a 138-tube bundle is 13. The ratio of shell diameter to tube diameter is 18, giving a shell diameter of (18)(⅝) = approximately 11 in.

A shell-side velocity of at least 2 ft. per sec. is desirable. The flow of organic liquid is 20,000/(55)(3,600) = about 0.1 cu. ft. per sec. Since Fig. 2 is based on a flow of 1.0 cu. ft. per sec., our desired velocity is represented by the curve for 2/0.1 = 20 ft. per sec. This velocity, however, must be corrected again for ⅝-in. rather than 1-in. tubes, or (20)(⅝) = 12.5 ft. per sec. So for 13 tubes across the shell, Fig. 2 indicates a baffle spacing of about 4 in.

To summarize, the required duty might be met by a shell-and-tube exchanger having 138 ⅝-in. tubes in a bundle 7½ ft. long, in a shell about 11 in. in diameter, and with baffles every 4 in. If unsuitable, another approximation may be made using different basic assumptions.

Cross-Sectional and Surface Areas for 16-Gage Tubes

Outside Diameter, In.	Number of Tubes Containing 1 Sq. Ft. Cross-Sectional Area	Surface Area, Sq. Ft. per Ft. of Length for Tube Bundle Containing 1 Sq. Ft. Cross-Sectional Area
½	1,340	175
⅝	746	122
¾	476	94
⅞	330	76
1	242	63
1⅛	185	55
1¼	146	48
1⅜	99	39



Convert Baume to Specific Gravity With a Slide Rule

Dale S. Davis, *Professor of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.*

As shown previously, portions of various scales on the slide rule can be used to estimate frictions factors[1] and the viscosity of water.[2] Another convenient approximation permits interconversion of degrees Baume and specific gravities between 6 and 35 deg. Baume for liquids heavier than water. The method makes use of the tangent and LL1 and LL2 scales of the log-log duplex decitrig rule.

For values of 14 to 35 deg. Baume, set 20 on the T scale opposite 1.16 on the LL2 scale and thereafter read degrees Baume on the T scale and specific gravities on the LL2 scale. For values of 6 to 14 deg. Baume, set 13.78 on the T scale opposite 1.105 on the LL1 scale and continue as before. For values below 6 deg. Baume, set the right hand index (0.1) on the C scale opposite 1.041 on the LL1 scale and change each Baume value to radians by dividing by 57.3. Thus for 3.54 deg. Baume, divide this value by 57.3 to attain 0.0618; opposite 0.0618 on the C scale read the specific gravity as 1.0255 in place of the actual 1.0250.

The following table shows the nature of the agreement between specific gravities estimated by this method and the actual values as calculated from the equation:

$$\text{Specific Gravity} = \frac{145}{145 - \text{deg. Be.}}$$

which is not well adapted to solution by slide rule.

Comparison of Actual With Slide Rule Results

Deg. Baume	Specific Gravity: Slide Rule	Specific Gravity: Actual	Deg. Baume	Specific Gravity: Slide Rule	Specific Gravity: Actual
1.44	1.0100	1.0103	16.08	1.1300	1.1300
3.54	1.0250	1.0255	20.00	1.1600	1.1600
6.24	1.0450	1.0455	23.15	1.1900	1.1900
9.49	1.0700	1.0705	26.15	1.2200	1.2200
13.18	1.1000	1.1000	29.93	1.2600	1.2640
			35.15	1.3200	1.3320

REFERENCES

1. Davis, D. S., *Chem. Met. Eng.*, **51**, 115 (July 1944).
2. Davis, D. S., *Chem. Eng.*, **58**, 142 (July 1951).

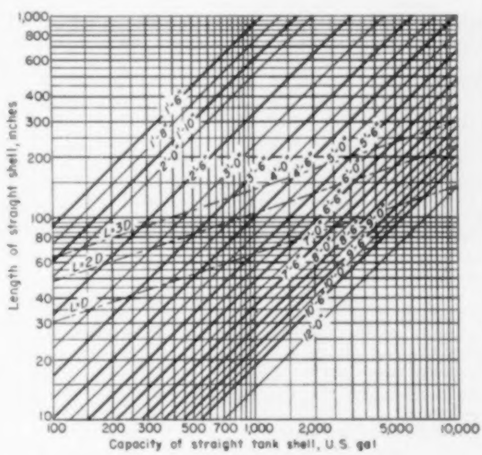


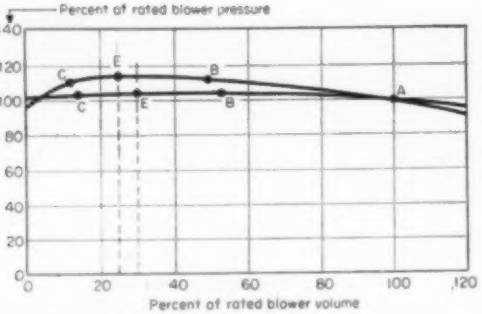
Chart Aids in Quick Estimation Of Tank Dimensions

Jagdish C. Agarwal, *Chemical Plants Div., Blaw-Knox Construction Co., Pittsburgh 30, Pa.*

A quick method of estimating tank dimensions, diameter and straight shell length for a given capacity, has been needed for a long time. The accompanying graph presents data from which several variations in dimensional relationships can be obtained with a minimum of effort.

For a desired L/D ratio, follow the capacity line vertically until hitting the desired L/D line. The closest standard shell diameter and shell length are obtained from sloping straight lines, and Y scale, respectively. The answer obtained can be taken as actual tank dimensions if capacity of dished heads is neglected.

For example, if an 800-gal. capacity tank is desired, with L/D ratio of approximately 1, the nearest standard tank diameter which will give an L/D ratio of approximately 1 is 5 ft. The straight sheet length will be 66 in.



How to Cure Pulsation in Centrifugal Blowers

O. W. Acheson, *Billmyre Blower Div., Lamson Corp., Syracuse, N. Y.*

When a centrifugal blower is used in the capacity range for which it was designed, pulsation is seldom a problem. There are, however, certain applications of blowers—where it is necessary to keep the blower running during periods of very small demand. In the case of certain heating processes these "turn-down" or "weekend holding" periods may call for as little as 10 or 20 percent of rated volume output of the blower. In such cases, surging can set up a pulsation which may disturb the process and cause overheating and consequent damage.

Such pulsation can be prevented—and corrected—if one understands the mechanics of pulsation.

The pressure-vs.-delivery curves shown in the sketch above are typical of all centrifugal blowers. The upper curve is that of a well-designed blower, and the lower curve of a "not-so-well" designed blower. Note that in both cases the pressure attains a maximum at some relatively low rate of air output.

If the demand on a blower is decreased in volume from a normal operating point A to another normal operating point B below the maximum-pressure point, the pressure at the blower merely rises correspondingly, and pulsation does not occur. If, however, the volume requirement is decreased beyond the maximum-pressure point E to a very low point, such as C, the following sequence of circumstances may set up surging.

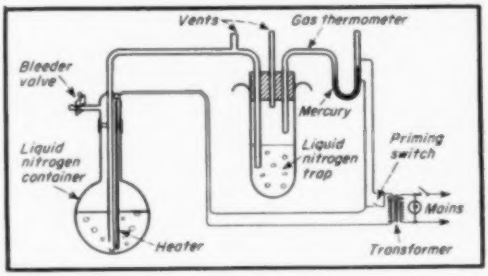
The blower delivery pressure first decreases from E to C at the blower itself. Thus for a moment, the pressure in the piping system connected to the blower is greater than the pressure at the blower itself. The air in the line then tends to reverse its direction and flow back into the blower until both pressures become equalized. When this has happened the blower again resumes its normal function of pumping air into the system—until the restriction at the line outlet again reduces throughput and causes the sequence to repeat—result, surging.

The frequency and intensity of surging depends upon: (1) the slope of the pressure-vs.-volume curve, (2) the rate at which air is being removed from the system, and (3) the volume of the pipe system to which the blower is delivering air. The same principles apply whether the centrifugal unit is operating as a blower or an exhauster.

The best way to prevent pulsation is to anticipate circumstances which might cause it. It will not occur with delivery above the point E. However, if the application may require low turn-downs, then the blower manufacturer should be informed so that he can select and specify a blower which will prevent pulsation.

If pulsation occurs in an existing installation, keep the delivery above the surge point by bleeding or recirculation if possible. Or use a smaller blower, or have a second smaller blower for turn-down. If surging is infrequent or of short duration, however, it may not be harmful and its effect can be eliminated at the use end by means of a surge tank. Finally, the manufacturer may be able to make slight changes in the design which will eliminate the pulsation by bypassing or other steps at the sacrifice of a little blower efficiency.

Actually, the more efficient a blower is, and the tighter the air system is beyond the blower, the more likely it is to surge at very low operating points. Fortunately, the uses for compressed air or gas, which demand blower operation at critically low output, are infrequent so that high-efficiency equipment can be used in all but the rarest of cases.



How to Supply Nitrogen to a Vacuum System Cold Trap

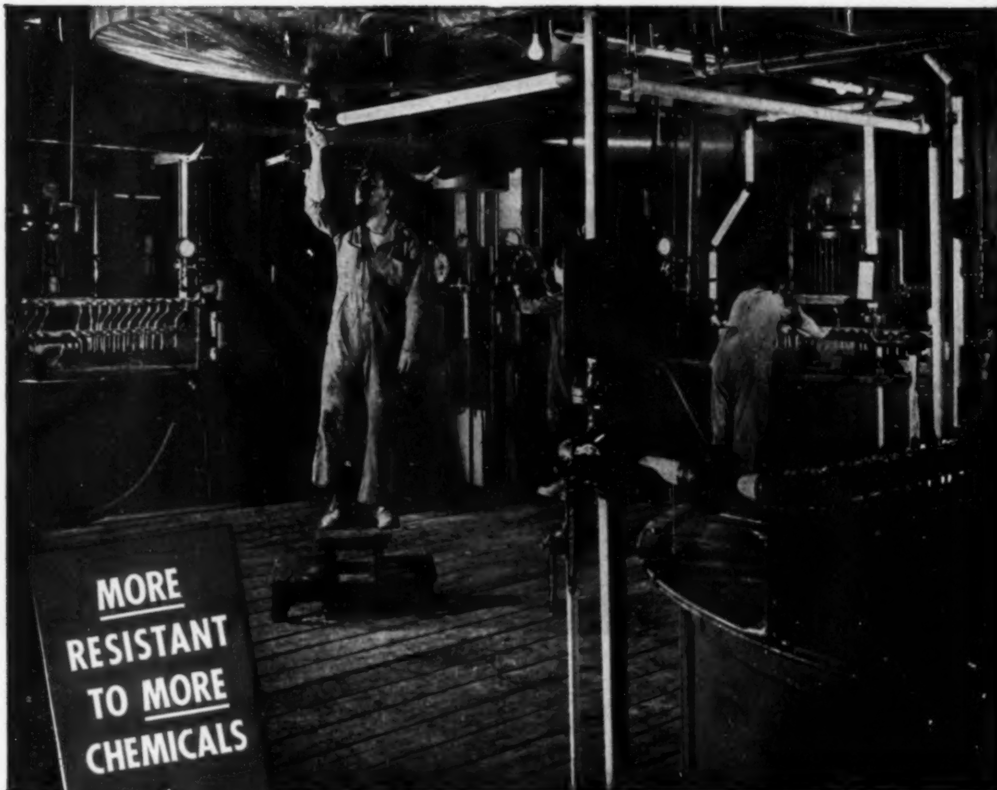
A simple automatic method for dispensing liquid nitrogen to vacuum-system cold traps has recently been developed by Jesse Sherwood of the National Bureau of Standards.

In most extreme high vacuum systems a trap, filled with some refrigerant such as dry ice or liquid nitrogen, is inserted into the system so that as the vapors pass over it, they condense and collect on the surface of the trap. However, these refrigerants evaporate rapidly and hence must be replenished at regular intervals. The NBS dispenser automatically performs this task, keeping the trap filled to any predetermined level for a period of time dependent only on the available supply of liquid nitrogen.

The dispenser consists essentially of a simple gas thermometer, a mercury pressure gage, a confined source of liquid nitrogen, and a nichrome-wire heater.

The gas thermometer, suspended in the trap, reacts to the temperature at some point near the desired level of liquid nitrogen. If the liquid nitrogen level is low, the gas (air) in the thermometer expands and causes the mercury to rise in the U-tube, completing the heater circuit. This switching effect applies 25 watts of power to a nichrome-wire heater at the bottom of the liquid nitrogen container. The ensuing evaporation generates gaseous nitrogen, and its pressure forces liquid nitrogen through a connecting tube to the trap. As the level of the liquid in the trap rises, the thermometer cools, the gas pressure decreases, the mercury column in the U-tube drops, the electric circuit is disconnected, and the flow of liquid nitrogen stops.

A vent in the delivery tube prevents excessive bubbling of the liquid in the trap. A bleeder valve on the liquid nitrogen container is also provided to remove gaseous nitrogen resulting from natural evaporation; adjustment of this valve is not critical. The U-tube should have an inner diameter of at least 6 mm.



HOT CORROSIVE SALTS almost too hot to handle

FOUR TIMES A DAY, metallic salts in hydrochloric and hydrofluoric acid solutions are heated to a near boil and cooled to room temperature, in these digesters and crystallizing tanks. The hot acids are extremely corrosive, and the constant change of temperature is rough on the tanks. Most materials would not stand up or would be too expensive.

Best answer was found in ACE hard rubber linings—the two-layer protection that is both chemically strong, and mechanically tough. Approximately 40 ACE rubber-lined tanks are now in service in this plant. Many have been on the job for eight years.

The fume ducts in the background, incidentally, handle hydrofluoric acid vapors. They, too, are ACE protected.

ACE hard rubber resists all alkalies, metallic salts, inorganic acids, hydrochloric acid any strength, nitric acid to 16° Be, sulphuric acid to 50° Be, phosphoric acid to 75%, and countless other corrosives. Other ACE plastics extend this range still further. Ask for catalogs of ACE-Clad and ACE-molded chemical equipment.

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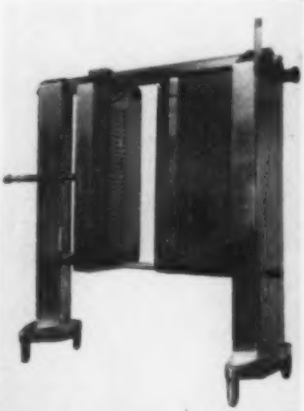
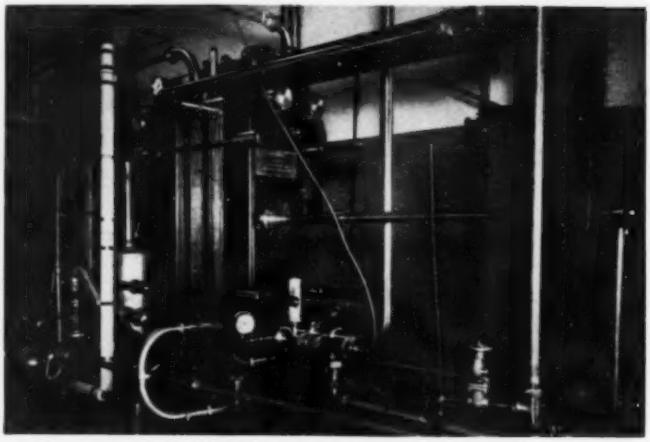




FOOD AND BEVERAGE industries have found these heat exchangers ideal for certain services.

Plate-and-Frame Heat Exchanger for Heavy Duty

New high-pressure, high-capacity model should be suitable for many chemical process applications.

(174A) The Paraflow, a plate-type heat exchanger which has found wide application in the food and beverage industries, has been recently made available to the chemical process industries in a heavy-duty model. This new model, the HF, has a pressure limitation of 120 psi., whereas previous models were limited to 45 psi.

Construction of the Paraflow resembles somewhat a plate-and-frame filter press. It is assembled from a series of metal plates, with gaskets providing the necessary seals between plates.

Since the choice of metals and alloys for the plates themselves is relatively wide, the main weakness of this type of heat exchanger at present is the gaskets. Gasket materials limit both the nature of the fluids which can be processed and the temperatures and pressures which can be used. Present gaskets of natural or synthetic rubber are unsuitable for use with many organic fluids.

Earlier plate exchangers had plates of cast bronze with separate dividing sheets, providing relatively wide liquid passages. Most exchangers now have plates pressed from mild steel, stainless steel, Everdur or aluminum sheet. Cast plates, however, still are employed for handling slurries which would plug the closer clearances used with pressed plates.

A properly designed plate heat exchanger is said to offer advantageous heat-transfer characteristics. Close clearance between plates provides a small hydraulic radius, while still permitting easy cleaning. This small clearance would be difficult to achieve with tubes of equivalent diameter.

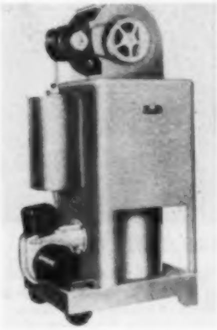
On the other hand, the small hydraulic radius reduces the Reynolds number, resulting in streamline flow and a tendency toward slow heat transfer. This tendency is overcome by corrugating the plates to induce a high degree of turbulence in the narrow gap between plates. A high heat-transfer coefficient actually is claimed. Although performance data are not customarily released for publication, the manufacturer cites a water-to-water heat exchanger in which a coefficient of 920 Btu./(hr.) (sq. ft.) (deg. F.) was observed. An investigation reported in the literature, however, found coefficients of 80 to 300 for hot water to GR-S latex.

The corrugations in the plates serve another useful function—they add rigidity to the thin metal stampings. The thickness of the metal could well be a limiting factor in performance, especially when the plates are made of stainless steel. For example, the resistance to heat flow of a stainless plate 0.1 in. thick would correspond to a coefficient of about 1,000. So in order to get coefficients on the order of the 920 just cited not only must the flow be extremely turbulent but the metal plate must be fairly thin.

The new Model HF Paraflow has 3½-in. diameter ports, which will pass 30,000 to 40,000 gph. without undue pressure drop. The minimum gap between plates has been set at 0.1 in. in order that solid-bearing and scale-forming liquids may be handled without excessive risk of plugging.

Each plate has a developed area of 4.6 sq. ft. The standard frame is large enough to handle 250 plates, making it possible to pack a lot of area into a small space. Plates are compressed in the assembly by a single central tightening screw. After compression four tie bars with screwed ends and adjusting nuts are clamped into position to take the compression load. These tie bars are designed to act as springs and extend with expansion.

The plate exchanger offers other practical advantages in addition to rapid heat transfer. It can be opened and cleaned in a minimum of time. Capacity can be changed or the duty varied by adding to or rearranging the plates. By using suitably designed connector plates, a single unit can perform several duties at once.—*Walker-Wallace, Inc.*



Space Heater Blows Along the Floor

(*175A*) A new 140,000-Btu. space heater is said to employ a novel principle of forced air circulation. By blowing warm air out of the heater's base along the floor, the manufacturer claims, it provides a 6-ft. high heat blanket and avoids the wasteful heating of overhead areas.

Known as the Model PW-140, this machine is designed to provide heating comfort in areas up to 3,000 sq. ft. of confined space or 1,600 sq. ft. of open space. It burns regular fuel oil of No. 3 or lighter grade. Measuring 21 by 33 by 58 in., it is self-contained and portable.—*Fageol Heat Machine Co.*

Dowtherm Vaporizer Is Electrically Heated

(*175B*) Electric heating elements provide the energy input for a new Dowtherm vaporizer, available in ratings of 100,000 to 1 million Btu. per hr. The unit is furnished complete with temperature controller, liquid level control, safety valve and other accessories.

Vaporizer drums range from 24 to 36 in. in diameter and from 45 to 72 in. long. In the smaller sizes each heating element extends almost the full length of the drum, enclosed in individual tubes. In the larger sizes two elements, end to end, are used per tube.—*Union Iron Works.*

Equipment Cost Indexes

(Marshall and Stevens Indexes of Comparative Equipment Costs, 1926 = 100)

Industry	Dec. 1950	Sept. 1951	Dec. 1951
Average of all	177.1	179.1	179.6
Process Industries			
Cement mfg.	169.5	171.5	172.3
Chemical	177.5	179.5	180.3
Clay products	164.5	166.5	167.3
Glass mfg.	167.6	169.6	170.4
Paint mfg.	170.8	172.8	173.6
Paper mfg.	171.1	173.1	173.9
Petroleum ind.	173.9	175.9	176.7
Rubber ind.	176.3	178.3	179.1
Process ind. avg....	174.9	176.9	177.7
Related Industries			
Elec. power equip...	179.1	181.1	181.9
Mining, milling	178.2	180.2	181.0
Refrigerating	195.8	198.6	200.1
Steam power	166.7	168.7	169.5

Compiled quarterly for March, June, September and December of each year by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. Indexes are prepared for 47 different industries, from which the eight process and four related industries listed here are selected. Published each month with the latest available revision. For a description of the method of obtaining the index numbers see R. W. Stevens, **Chemical Engineering**, Nov. 1947, pp. 124-6. For a listing of annual averages since 1913 see **Chemical Engineering**, Feb. 1952, p. 191.

IN BRIEF—A capsulated listing of this month's newsworthy equipment.

Don't Forget: Reader service postcard inside back cover will bring you more information. Use these key numbers

Bin Level Indicator Gives Positive Signal

(176A) The Bin-Vue is a new bin level indicator which is said to give a sure, positive automatic indication at top, middle or bottom of the bin. Simple in principle and execution, it is priced at only $35.

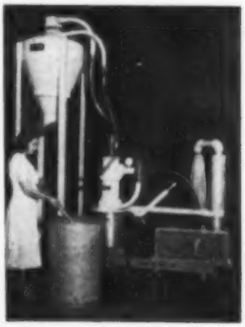
This device consists of a 1/2,000-hp. motor turning at 5 rpm., connected to a shaft by means of a torsion spring. Alongside is a limit switch. At the end of the shaft is a four-blade paddle which is free to turn as long as material in the bin does not touch it.

Once touched by the material, the paddle stops and the motor keeps on turning until the spring by torsion actuates the limit switch. The switch then kicks out the motor and actuates any other desired signal. The spring is kept under torsion until the material at the paddle falls away. The paddle then turns the spring away from the limit switch and reactuates the motor.

The Bin-Vue can be used with any bulk material that flows, it is claimed. It can be supplied in an explosion-proof model for hazardous locations.—*Convair Corp.*

STORAGE RACK SAVES SPACE, REDUCES CONFUSION

(176C) **You can stack drums to ceiling height with this new welded steel storage rack. You can remove any drum without shifting or disturbing the others or even use faucets for drawing off small quantities. Company will design racks for any size drum or special shape containers.—Equipment Manufacturing, Inc.**



Portable Air Conveyor Avoids Dust Nuisance

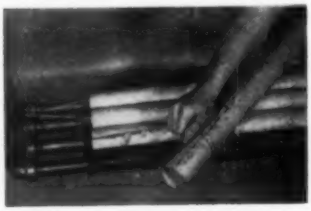
(176B) A portable suction-type air conveyor is designed to fill and replenish hoppers or bins and to empty containers and shipping drums. Use of this conveyor helps avoid dust nuisance and spillage.

In operation, material is picked up by a suction nozzle and conveyed via a flexible hose to an elevated receiver. A gate valve at the bottom of the receiver can be either manually opened and closed or set for automatic operation. In the latter case material is fed into the machine hopper by gravity until the receiver is empty. The gate closes instantly when the conveying system is started.

All metallic equipment in contact with the material conveyed can be furnished in stainless steel.—*Airborne Conveyors Corp.*

Drum Up-Ender Fits Fork Trucks

(176D) A new manual drum up-ender consists of two shoes which slip over the forks of any standard fork truck. Welded to the shoes are rubber-faced grab plates that clamp around the drum to hold it firmly. An advantage of the new device is that you can safely empty drums from any height within comfortable arm reach. —*Baker-Raulang Co.*



Tubing Package Protects Extended Surface

(176E) Expensive wooden boxes or crates have given way to cardboard covers for protecting finned tubes during shipment. The cardboard covers can be easily removed by the receiver simply by ripping along the length with a built-in pull-string. Pipes can now be stacked without danger of crushing the fins, and even stepped on without damage.

This container has been patented, but licenses are available.—*Proctor & Schwartz, Inc.*

Packaging & Handling Briefs

Hand Lift Pallet Trucks—Dual-purpose superstructure enables them to handle 7 and 12-in. skids as well as single or double-faced pallets. Yale and Towne Mfg. Co. *(176F)*

Self-Dumping Trailer—Model T-SRF-½, with ½ cu. yd. capacity, designed for pulling by hand, lifting and transporting by fork lift truck, and towing singly or in train by tractor. Phillips Mine & Mill Supply Co. *(176G)*

Heat Sealer—For manufacture and closure of large bags, pouches, etc. Jaws are 38 in. long to seal standard 36-in. wide material. Movable jaw operated by compressed air; heating is by electricity. Pack-Rite Machines. *(176H)*

Portable Elevator—Powered by an air motor for safe use in hazardous locations. Air consumption at 80 psi. is 2.5 cfm. per ft. of lift. Barrett-Cravens Co. *(176I)*

Fork Lift Trucks—Five new models with capacities of 2,000 to 4,000 lb. Towmotor Corp. *(176J)*

THE CARE AND NURSING OF TANK CARS

Use hot water or steam to open a frozen outlet valve.

Another way to get more from your GATX tank cars

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HEAT PUMP now in trial service.

MELTING metals suspended in mid-air.

Year of Electrical Progress

A review of Westinghouse's engineering activities for the past year reveals many items of interest. Here are a few selected highlights.

Although the thermodynamic principles of the heat pump are well known, major practical obstacles have retarded its commercial development. Real progress, however, is being made in that direction. This past winter three new units, two rated at 5 hp. and one at 3 hp., have been in actual service in homes in Florida, Texas and Virginia.

Tests a year ago on an earlier unit showed the frosting problem to be less serious than previously feared. Thus it does not seem necessary to apply heat to prevent freezing at low temperatures. Also it was found that the practical limiting temperature of operation is not around freezing—the unit can be operated continuously down through zero.

▶ **Riding the Rails**—The ignitron rectifier, widely accepted by the electrochemical industries for conversion of a.c. to d.c., is now on rails. The first two ignitron-rectifier locomotives recently began their trial runs. This design combines the advantages of a.c. power transmission to the locomotive itself with the desirable performance characteristics of d.c. traction equipment. It may make possible future rail electrification at 60 cycles instead of the lower frequencies preferable when single-phase commutator motors are used.

▶ **Long-Distance Control**—An established idea in power transmission is being adapted for oil and gas pipelines. This is the operation of remote apparatus with basically the same supervisory-control equipment used by electric power companies for years but modified for pipeline practice.

On a Texas pipeline, for example, one operator will control entirely a booster station 40 mi. away and a main-line valve 80 mi. away from the control station. Signals will be interchanged between the control and the controlled stations over a microwave system previously installed for communication purposes.

▶ **Look! No Crucible**—A wall-less crucible would overcome many problems encountered when melting certain metals, such as titanium and molybdenum, which react with refractory crucible materials at high temperatures. This is more than just fantasy—Westinghouse research engineers have induction-melted metal suspended in mid-air by a strong magnetic field. Supplied with 10,000-cycle energy, the pieces of metal spin rapidly in space, assuming, when molten, the shape of toy top.

So far float melting has been applied successfully only to laboratory melts involving small samples, and to a very limited number of metals. Nevertheless, the idea has been employed to advantage in research for metals in lamps, electronic tubes and other high-temperature applications.

Three new oil tankers took to the water last year, each powered with a single 16,500-hp. steam turbine with inlet steam conditions of 1,000 deg. F. and 600 psi. These conditions are more representative of central-station practice than marine service. In fact, only a few land turbines operate at that high a temperature.

▶ **Exploring Mixed Gases**—Research is continuing on the performance in fluorescent lamps of mixtures of the inert gases—neon, argon, krypton and xenon. During the past year a 50-50 mixture of krypton and argon has almost displaced the earlier all-argon lamp. Now a mixture of 75 percent krypton and 25 percent neon has been found to have highly desirable features.

Although the performance in a fluorescent lamp of each of the several gases by itself is known, it cannot yet be predicted what a mixture of two of them will do, much less a mixture of three or four. For some reason the ultraviolet response of two or more gases in combination is not simply a composite of the gases separately.

More precise control for arc furnaces may come from recent improvements in carbon-arc searchlight control. The new control maintains a much more stable arc over a wide range of current. It responds to arc drop variations of 0.1 v. or a current change as small as 0.1 amp.—*Westinghouse Electric Corp.*

Storage Batteries With Polystyrene Cases

(178A) A new line of storage batteries, available over a capacity range of 10 to 100 amp.-hr., are made with cases of polystyrene. These cases weigh 40 percent less than conventional ones, are smaller in over-all dimensions and, because of their transparency, give a visual indication of electrolyte level. Of special importance today is the fact that styrene is more readily available than other suitable container materials.—*Gould National Batteries, Inc.*

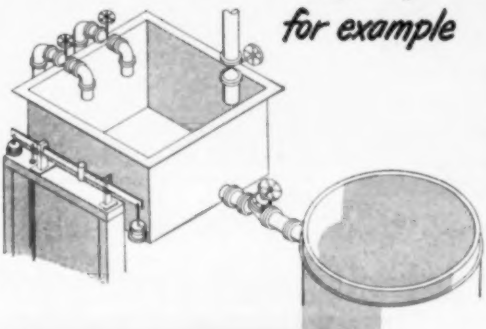
Electrical & Mechanical Briefs

Overload Release—Protects machinery and drive against excessive load. Designed for use with the Torque-Arm speed reducer. Dodge Mfg. Corp. *(178B)*

Paint Sprayer—Heavy-duty Paintmaster features an extra powerful air-operated reciprocating pump for handling heavy paints and other fluids. Gray Co., Inc. *(178C)*

Found: This Good Alternate for Alloy Valves

on chrome tanning liquor, for example



THE INSTALLATION

At Gutmann & Co., tannery, Chicago, on outlet of open scale tank for mixing highly corrosive basic sulphate of chrome solution used in tanning.

THE HISTORY

This plant had more than its share of trouble with various valves and cocks tried in this service. The highly corrosive solution caused rapid seat wear, leakage, seizing, and constant stuffing box maintenance was necessary. The inoperative valves, and shut-downs for repairs played havoc with the daily schedule of solution mixing.

All this trouble has stopped since the plant installed a Crane No. 1615 Iron Body Packless Diaphragm valve with Neoprene diaphragm, disc insert, and body lining. Even after 2½ years in this severe service, the valve remains absolutely tight; shows no corrosive or erosive effects, no undue mechanical wear, and operates as smoothly as when new. Maintenance cost to date—zero.

VALVE SERVICE RATINGS

SUITABILITY: *Neoprene lining good*

MAINTENANCE COST: *None - inspection only*

CORROSION-RESISTANCE: *O.K. - no corrosion showing*

SERVICE LIFE: *In 2½ years - still like new*

OPERATING RESULTS: *No fluid loss - no valve trouble - no production loss*

PRICE: *Lower than expected*

AVAILABILITY: *Regular Crane item*

THE VALVE

Crane No. 1615 Packless Diaphragm Valves with Neoprene Lining. Diaphragm acts as bonnet seal only; is not subject to rapid wear. Separate disc with Neoprene insert shuts off flow even should diaphragm fail. Neoprene body lining makes these valves highly suitable for many corrosive fluids, erosive sludges and slurries. Also available unlined. See your Crane Catalog or Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why, More Crane Valves Are Used Than Any Other Make!

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VALVES • FITTINGS • PIPE • PLUMBING • HEATING

PVC Pipe and Sheet Can Be Hot-Gas Welded

(180A) Boltaron 6200, a new unplasticized rigid polyvinyl chloride, is available in the form of pipe, bars, sheets and welding rod. It can be fabricated by stamping, shearing, sawing and drilling, and can also be welded by a hot-gas process. In the illustration a flange is being welded to the end of a Boltaron pipe.

High tensile and impact strengths are claimed for this material. In addition it is light in weight, non-flammable, and resists many chemicals and other fluids.

Sizes available are: for pipe, $\frac{3}{8}$ to 4 in. I.P.S., and for round bars, $\frac{1}{4}$ to 1 in. diameter, both in 10-ft. lengths; for $\frac{1}{16}$ to $\frac{3}{8}$-in. sheets, 30 by 60 in.; and for $\frac{7}{16}$ to 1-in. sheets, 24 by 50 in. —*H. N. Hartwell & Son, Inc.*

Tanks and Hoods Made of PVC

(180B) Polydur, an unplasticized, rigid form of polyvinyl chloride, is now available in fabricated tanks, hoods, vents and ducts. Tanks are made in two types—a self-supporting type made from sheets $\frac{1}{4}$ to 1 in. thick, and as $\frac{1}{8}$-in. thick liners for wood, concrete or metal tanks.

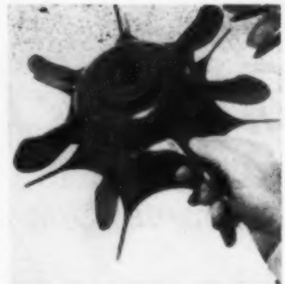
At temperatures of 250 to 300 deg. F. Polydur can be formed and welded into almost any design. Among its desirable properties are resistance to many corrosive chemicals, high dielectric strength, and absence of brittleness at sub-zero temperatures. Fabricated tanks and other products require no internal or external protective coatings.—*Munray Products, Inc.*

Glass-Reinforced Resin In Various Forms

(180C) Pla-Tank is a polyester resin-bonded Fiberglas available in the form of pipe, tanks, hoods and ducts. It has good resistance to dilute acids and solvents. It is not recommended for use with H_2SO_4 or HNO_3 of greater than 50 percent concentration. Ketones and chlorinated solvents do not visibly attack Pla-Tank.

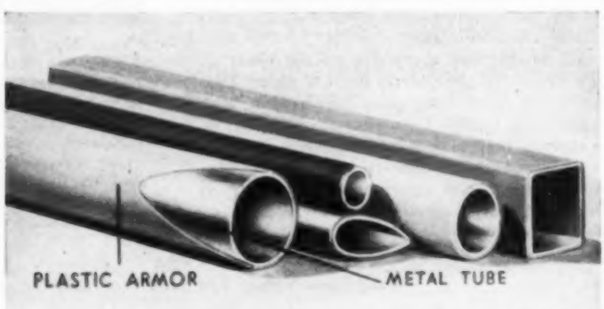
Pipe is made in inside diameters of 6, 8, 10 and 12 in., in lengths of 6, 12 and 18 ft. Joints are made in the field by slipping a straight end into a belled end and welding by wrapping resin-soaked glass mat around the joint. A catalyst which is supplied separately is mixed with the resin at the last minute; curing requires only about 30 min. under normal temperature conditions, although you may want to speed things along during cold weather by use of a heat lamp. In the illustration, the man in the foreground is preparing to make a joint; the other one is starting to cure a new joint.

Here's an idea of the cost of Pla-Tank: A 6-ft. length of 6-in. pipe, belled on one end, costs \$6; each 90-deg. elbow costs \$27; a tee costs \$40; a joining kit sufficient for one field weld costs \$6. Prices for 12-in. pipe and fittings are just double those for 6-in., with the intermediate sizes in proportion. Prices for tanks range from about \$20 per cu. ft. in small sizes down to about \$5 per cu. ft. in larger sizes.—*The Chemical Corp.*



PLASTIC BLOWER

(180E) Glass fiber-reinforced polyester resin replaces critical aluminum and bronze for blowers in small TEFC motors. Plastic is lighter, more resistant to abrasion and corrosion.—Westinghouse Electric Corp.

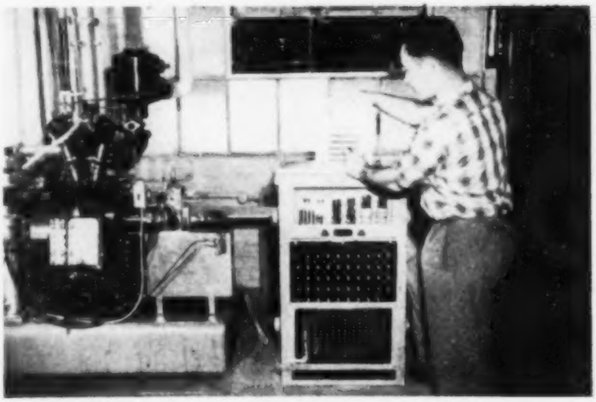


PLASTIC-ARMORED METAL TUBING MADE IN NEW SHAPES

(180D) **Dekoron tubing, armored with vinyl or polyethylene plastic is now made in square, triangular, oval and streamlined cross-sections. The plastic armor is applied by a patented extrusion process over any kind of metal core.—Samuel Moore & Co.**

Temperature Controller Adjusts On-Off Times

(182A) A new proportioning temperature controller, the Model JP Gardsman, is said to adjust automatically the ratio of on and off times over a given cycle to maintain straight-line control. Yet this instrument is reported to be in the same price range as regular on-off controllers. It is available in 36 standard scale and thermocouple ranges and is powered from either 115 or 230 v.—*Taco West Corp.*



THERMOCOUPLE SWITCHBOARD MONITORS 48 POINTS

(182D) **When any one of 48 temperatures exceeds a predetermined safe value, an indicating unit with 48 individual lights shows which point is overheated. The temperature of any single point can be followed on the indicating meter by inserting a plug into the proper jack. Heart of the device is a scanning switch rotating uniformly with a 5-sec. period. On each revolution one section of the switch samples each thermocouple in turn.—National Bureau of Standards.**

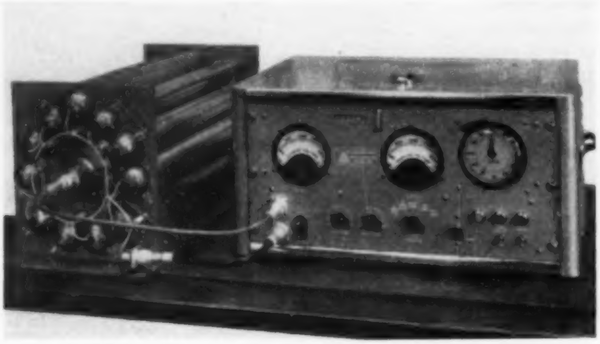
Miniature Recorder For Graphic Panels

(182B) A new independently powered miniature strip chart recorder with an electronically actuated pen has been designed for use with the recently announced Autronic control system (*Chem. Eng.*, Nov. 1951, p. 201). It is a servo-powered null-balance device, providing an accurate and instantaneous record of the measured variable. At maximum speed the pen can traverse the 3-in. chart in approximately ½ sec.

The pen is actuated independent of the chart drive and measures and records over the range of 0 to 0.5 v. a.c., the standard output transmission of all primary elements in the Autronic system. This makes the recorder interchangeable and usable without recalibration for circuits controlling temperature, pressure, level or flow. A special pen movement gives a true linear record.

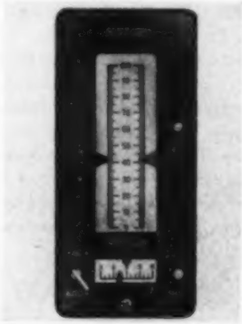
The mechanism can be pulled out from the case approximately 3 in. to allow inspection of past records without stopping the recorder. This allows the pen to be inked without interruption of the trace.

The Autronic recorder measures 4⅞ by 5 in. on the control panel. It fits in a metal frame which is 14½ in. deep.—*Swartwout Co.*



AGE DETECTOR MEASURES ISOTOPIC CARBON 14

(182C) **This apparatus can determine the age of any historical artifact, composed of organic material, between 1,000 and 25,000 yr. old. It measures the content of the carbon-14 isotope in such things as buried wood found in King Tut's tomb.—Radiation Counter Laboratories, Inc.**



Indicating Controller For Graphic Panels

(182E) The Consotrol is a new indicating pneumatic receiver-controller for use with graphic and console panels. It is designed to occupy a minimum of panel space, with its largest dimension being its depth behind the panel face.

A manual control sub-panel includes a calibrated valve-position indicator, manual control setting and transfer

switch. They are permanently mounted on the panel; when you remove the automatic control unit, you leave the manual unit in undisturbed operation. —*Foxboro Co.*

pH Meter With Flashing Signal

(183A) The Model 20 Compax is a new self-contained portable pH meter which is said to combine the precision of a linear potentiometer with the simplicity of single dial operation. New features include a unique flashing signal which eliminates meters, points, and reset knobs and establishes the reading point precisely.

The electrode system is automatically brought to operating position when the instrument cover is opened and returned to storage within the case when the cover is closed. All operations of standardization and measurements are accomplished with a single calibrated dial. — *Coleman Instruments, Inc.*

Instrumentation Briefs

Multiple-Tube Purge Meter—Two, four or six tubes combined in a single integral unit bored from a block of acrylic plastic. Eliminates packing glands and breakable glass tubes. Separate needle valves for each tube. Brooks Rotameter Co. (183B)

Message Annunciator—Abnormal condition sounds horn and lights message. Operator silences horn, message remains lighted until condition is corrected; correction is announced by a different kind of audible signal. H. R. Kirkland Co. (183C)

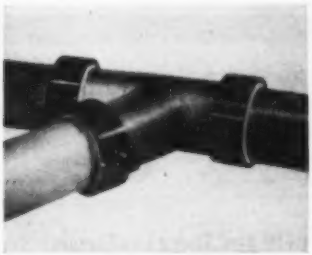
Volt-Ammeter—Snap-around type, Amprobe Model 1200, with six ammeter ranges up to 1,200 amp. a.c. and three voltmeter ranges up to 600 v. a.c. $67.50, including case. Pyramid Instrument Corp. (183D)

Dial Thermometer—New process for welding thin sections of stainless steel eliminates silver solder, increases range of applications. Rochester Mfg. Co. (183E)

Infrared Spectrometer—Model 112 incorporates double-pass optical system to get improved resolution. Will better detect nearly similar materials. Perkin-Elmer Corp. (183F)

Light Comparator—Colorede will record and automatically control processes through use of chemical color indicators. Design includes fail-safe devices. Instrument Development Laboratories, Inc. (183G)


STRAIGHT SECTIONS are joined with threaded plastic collars.




SPLIT COLLARS facilitate assembly in cramped quarters.

Screwed Ends for Ceramic Pipe

Vinyl and phenolic plastics team up to form a new way to join clay pipe and fittings.

(184A) A new method of joining ceramic pipe uses a tapered male threaded section of vinyl resin cast directly on each end of the pipe or fitting in conjunction with a matching female collar of molded phenolic resin. The clay pipe is a premium grade with extra-heavy walls to withstand severe service, whether buried or exposed.

The threaded plastic ends are applied at the factory, using a vinyl resin plastisol which is finally fused at 350 to 375 deg. F. This technique makes it possible to produce resin castings of any desired thickness which are tough and flexible. Flexibility of the resin contributes a property highly desirable in ceramic piping installations—joints can be deflected as much as 6 deg. without leakage.

To assemble the joint, you simply thread the phenolic collar over the vinyl end of one of the clay pipes and add the next section by turning it into the collar by hand. Three complete revolutions of the pipe by hand and a fourth and final turn with a strap wrench do the trick. Joints have been tested at water pressures as high as 50 psi. without leaking.

In hard-to-get-at places, you use a split collar bolted together at the sides. This type of joint is especially useful when connecting elbows, tees and wyes. A soft plastic band is placed over the threads to assure a smooth surface for the collar. Tightening the collar compresses this material into a tight joint.

This development has been named the Screw-Seal. Right now pipe and fittings are available in 4, 6, and 8-in. I.D. Fittings include 30 and 45-deg. curves and 90-deg. elbows with both short and long radius, tees, crosses, wyes, double wyes and caps. Pipe comes in 3-ft. lengths.

Chemical resistance is limited by that of the organic materials. Services involving strong alkalis and solvents are out. But the manufacturer presents an imposing list of 54 fluids with which Screw-Seal can be safely used. The list includes most acids, salts and gases, and such organics as acetic anhydride, ethyl acetate and phenol.—*Robinson Clay Product Co.*

Propeller Fan For Pressure Service

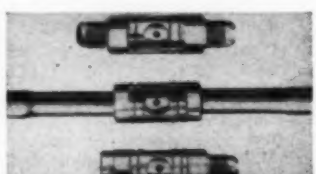
(184B) Unlike usual propeller fans, which are suitable only for free delivery or for very low static pressures, the new Type PLF fan is designed for heavy-duty industrial applications where large volumes of air must be moved under appreciable static pressure. The airfoil propellers are of cast aluminum. Available sizes range from 16 to 48 in., and air deliveries from 2,900 to 37,000 cfm.—*Chelsea Fan & Blower Co.*

Fluid Piston Pump Handles Suspended Solids

(184C) The recently developed Hydrex pump combines the ability to handle fluids containing suspended solids at high pressures with an extremely gentle action. Working on the fluid piston principle, this pump can be used to transfer materials which heretofore were considered unpumpable.

The device consists basically of two cylinders and a high-pressure pump. The pump delivers a suitable hydraulic fluid to the upper section of each cylinder in an alternating cycle controlled by a four-way valve. The amount of fluid in the system is constant, being withdrawn from one cylinder as it is pumped into the other.

At the lower ends the cylinders float on the product line. As the upper fluid is withdrawn from a cylinder, the bottom check valve opens and permits the product fluid to enter from the suction or supply side. As upper fluid is pumped in, another check valve opens and the product leaves via the discharge line. Where contact between the pumping medium and the product must be avoided, a suitable membrane is provided.—*Manton Gaulin Mfg. Co., Inc.*



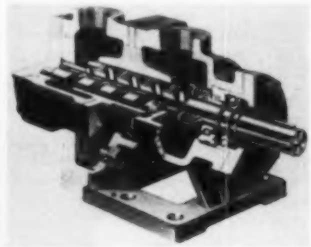
Flow Indicator Is Installed in Line

(184D) Known as the Liquid Eye, a new flow indicator consists of a brass housing in which is inserted a high-pressure glass tube. A ceramic

eye in the tube visually magnifies when liquid is passing through the indicator. The device is installed directly in the line in a straight-through arrangement which minimizes pressure-drop.

The brass housing and ends are machined to close tolerances and the glass tube is ground and lapped by a special process. The tube is spring-mounted for shock resistance, and the method of seating the gasket against the ends of the glass prevents the glass from touching the housing. Assembly is completed with torque wrenches.

Three styles are available in connecting tube sizes of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. —*Allin Mfg. Co.*



Rotary Pump For Lower Costs

(186A) A new Imo rotary positive-displacement pump is said to save up to 40 percent in initial cost over previous models for similar pressure ratings. This one is designed to handle a wide variety of oil pumping jobs at pressures up to 275 psi. Top capacity is 80 gpm.—*De Laval Steam Turbine Co.*

Power Ventilators With High Capacities

(186B) Powered by direct-connected axial flow fans, these new ventilators are claimed to provide higher capacities than conventional types. The air shaft extends above the fan and terminates in a pair of dampers that open and close automatically as the fan is turned on and off. Their free opening allows an unrestricted

volume of air to be driven vertically upward at high velocity.

Seven sizes, with motors from ¼ to 5 hp., provide capacities ranging from 5,000 to 75,000 cfm. Standard construction is of galvanized steel, but other metals may be used, such as protected metal, aluminum, stainless steel and Monel.—*Burt Mfg. Co.*

Welding Coupling Eliminates Scale

(187A) A new welding coupling now makes it possible to eliminate welding scale from piping systems. The coupling consists of two forged halves which are each welded first to the pipe or fittings to be joined. They are short enough to permit easy cleaning of the inside surfaces of scale or protrusions formed by the attachment welds.

When the two halves of the coupling are brought together for the final weld, the tongue of one slips into the groove of the other. A circumferential cavity directly beneath the beveled welding area prevents burn-through or formation of icicles in the interior. The cavity also insulates the interior from extreme welding heat, preventing scaling.

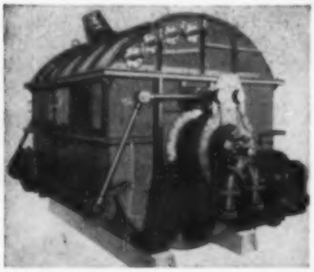
The tongue-and-groove arrangement makes piping easy to align. Another feature is that when piping is to be disassembled the coupling can be taken apart and re-used.

The new couplings are available in sizes from 1¼ in. through 12 in. in carbon steel, stainless steel, aluminum and other materials.—*Tube Turns.*

Fluids Handling Briefs

Ventilating Fans—Panel vent sets with wheels 24, 30 and 36 in. dia. and air-moving capacities up to 13,000 cfm. for free delivery or relatively low static pressure. Listed at $188 and up. DeBothezat Fans Div. *(187B)*

Steam Pumps—New steam ends rated up to 250 psi. Improved lubrication of valve gear gives longer bearing life. Worthington Pump & Machinery Corp. *(187C)*



Continuous Vacuum Filter With Vapor-Tight Hood

(188A) A recently designed standard continuous vacuum filter is provided with a vapor-tight hood, a feature formerly found only on special filters. This design now permits the continuous handling of many toxic or flammable products which would normally require batch pressure filters. —*Oliver United Filters, Inc.*

High Capacity Mixers Of Welded Construction

(188B) Although these custom-made mixers were originally designed and built for paint manufacture, they are suitable for many processing applications. The 400- to 1,200-gal. tanks are constructed of welded heavy steel plate. Agitators are of special design; special scrapers prevent build-up of material on the sides and bottom of the tank.—*Lloyd Engineering Co.*

Vertical Stone Mills Are Recently Improved

(188C) Among recent improvements in vertical stone mills is the development by the Carborundum Co. of several types of rotor and stator stones for processing a variety of chemicals and drugs. These stones, in production models, are 7 in. in diameter and have surface areas of approximately 38 sq. in. They are said to be self-sharpening and, therefore, to require no dressing.

Other improvements affect production capacity and quality control. An external handwheel controlled micrometer adjusting device raises or lowers the rotor stone. The degree of control can be appreciated from the fact that one full turn of the handwheel causes only 0.001 in. difference in the rotor stone elevation.—*Morehouse Industries.*

Glass Filter Cloth Is Durable, Flexible

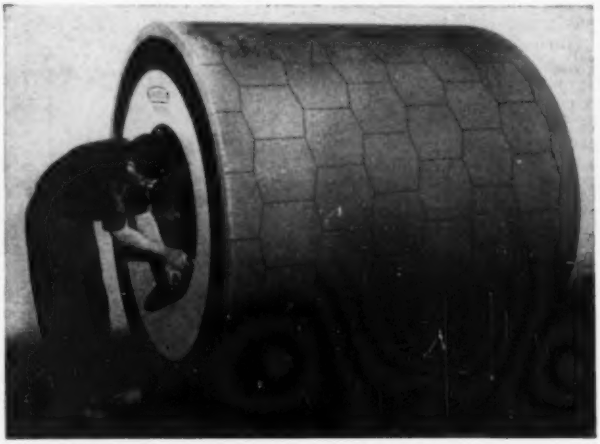
(188D) A new process of impregnating glass cloth with a silicone transforms the ordinarily brittle cloth into one which is said to be durable and flexible. The impregnated cloth was developed in an effort to find media which could be used in dust filters operating at temperatures too high for wool or cotton. Although untreated glass cloth satisfies the temperature requirements, it cannot be used because of its brittleness.

The new cloth can be used at temperatures as high as 550 deg. F., it is claimed, whereas wool or cotton are normally limited to 200 deg. Smoothness of the cloth contributes another advantage—the fabric cleans more easily, with a minimum of shaking.—*Menardi & Co.*

Freeze-Dryer For Research Use

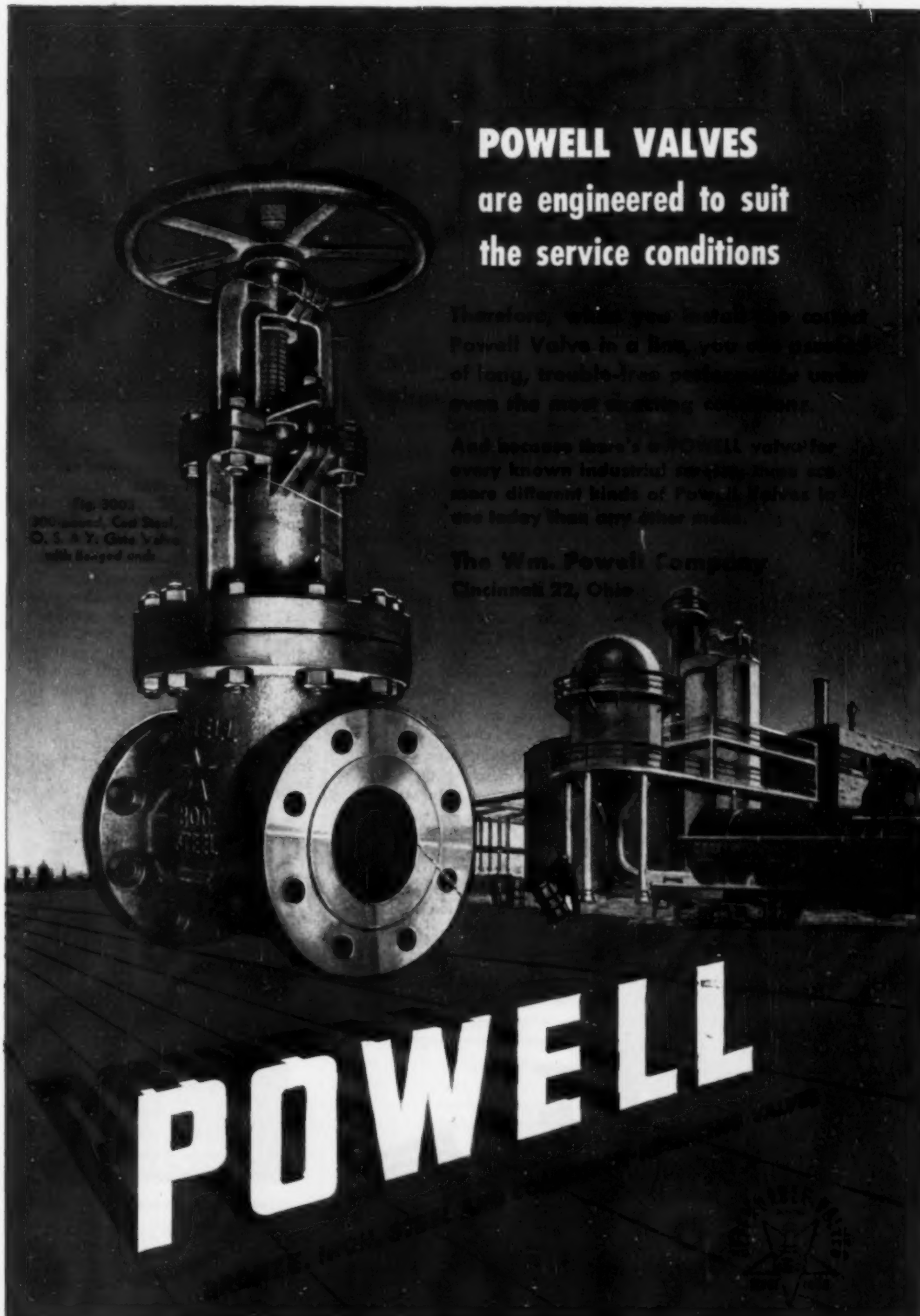
(188F) A new unit for investigating freeze-drying on the laboratory or pilot scale has recently been introduced. The drying chamber is a steel cylinder, 18 in. in diameter and 2½ ft. long, with a clear plastic door. A vacuum pump provides pressures of less than 100 microns.

Energy for drying is supplied by resistance wires radiating at a carefully selected frequency in the infrared range. It is said to be possible to select a wave length which will give the greatest possible absorption by the water to be removed. Energy is supplied at 110 v. to an autotransformer rated at 1 kva., 7.5 amp. *Proctor & Schwartz, Inc.*



WORLD'S LARGEST PULPSTONE WILL USE 5,000 HP.

(188E) **The largest pulpstone ever made was shipped recently to a paper mill in British Columbia, where it will be used to grind wood into pulp for newsprint. Made of silicon carbide, it measures 67 by 69 in. and weighs more than 10 tons. It will require 5,000 hp. to drive it at a surface speed of 5,000 ft. per min.—Norton Co.**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the service conditions
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NEW
SAFETY EQUIPMENT

Respirator Valve Doubles As Filter

(190A) A new air-flow control valve assembly for use with air-line respirators and masks has recently been approved by the Bureau of Mines. This valve regulates air flow from a compressed air source to an operator using air-line breathing equipment. It also acts as a secondary air filter.

Three parts—a cartridge container, a cartridge, and the air flow check valve—comprise the entire assembly. A position action adjustment knob on the container regulates the amount of air flowing to the user. Easy to set, the knob cannot be changed accidentally. Air flow cannot be cut to less than 2 cfm.—*Mine Safety Appliances Co.*

SAFETY SCOREBOARD

(190B) Here's a way to chalk up your daily safety record. Sign is made of 20-gage metal, 20 by 30 in., finished with a green background meeting ASA color standards.—Industrial Products Co.

Emergency Light Turns On Automatically

(191A) This automatic emergency light turns on when the regular power supply fails. Plugging into any 110-v. line, it comes on only upon interruption in the regular lighting circuit. It runs on a 6 or 7½-v. dry cell.

The unit is self-contained and portable. It provides a 21 candlepower floodlight, sufficient for emergency operations or rescue work.—*General Scientific Equipment Co.*

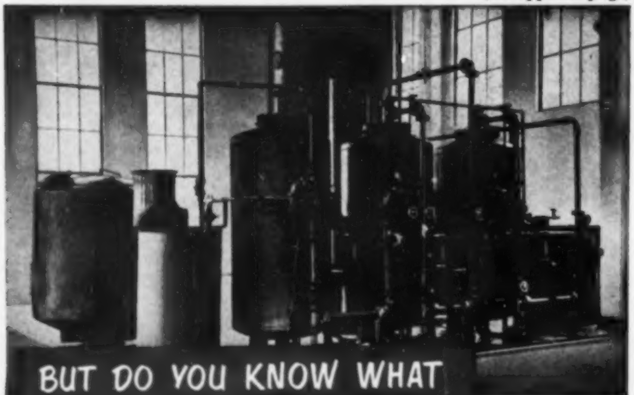
Vinyl-Coated Gloves Made By New Process

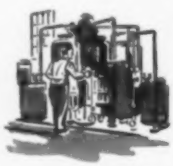
(191B) A new line of vinyl-coated gloves is made by a new centrifugal process which is said to provide exceptional adhesion of the resin to the canvas as well as freedom from pinholes. These gloves will resist many chemicals and are flexible over a wide temperature range. They sell for $8 per doz.; quantity discounts are available.—*Houghton Laboratories, Inc.*

Dust Respirator Designed for Comfort

(191C) A new respirator is designed for a high degree of user comfort. Called the Dustfoe 55, here are some of its salient features:

1. It weighs only 2¾ oz., 25 percent less than previous models.
2. A 50 percent reduction in width





of the filter holder reduces the blind area and greatly increases the downward vision.

3. Breathing resistance is said to be cut in half.

4. The filter is made of charged resin-treated felt which creates a static electrical field and supplements the mechanical filtering action.

In addition, the simplicity of construction allows for quick changing of filters and easy replacement of parts.—*Mine Safety Appliances Co.*

Fire Detector Depends on Rate-of-Rise

(192A) A recently developed fire detection system is designed to distinguish fires from other causes of temperature rise. A slow, gradual temperature rise, or a sudden but momentary rise, will not actuate the detector. However, an abnormal continued rise, such as produced by fire, will actuate the device.

Temperature rise in the protected space causes an expansion of air in a tubing circuit, both ends of which terminate at compensators of determined capacity. From these, expanded air travels up through breathers which permit it to be released to the outside atmosphere at a definite rate. The breathers permit a slow rise to pass undetected; the compensators permit a sudden momentary rise also to pass. But a fast continued rise causes the air to expand faster than the breathers can discharge it, thus actuating the alarm.

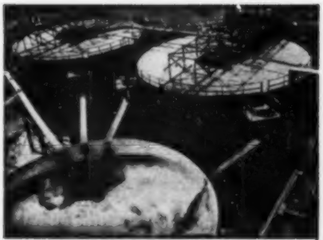
It makes no difference whether the protected space is a refrigerated area at 10 deg. F. or a hot process area at 100 deg. F.—it is the rate of rise, not a fixed temperature, which actuates the alarm.—*Walter Kidde & Co., Inc.*

Heat-Repelling Glove Uses Aluminum Coating

(192B) A new aluminum-lined asbestos glove is designed especially for use by workers whose hands are exposed to radiant heat. Constructed of a sheet of aluminum-coated fabric between two layers of heavy asbestos, the glove is jersey-lined, providing maximum heat resistance without causing skin irritation.

Experimental tests have shown that this glove reflects up to 90 percent of radiated heat. It is reported that no visible effects were indicated after handling objects heated to 1,200 deg. F. Moderately priced, the glove can be worn on either hand.—*Milburn Co.*

—*End*



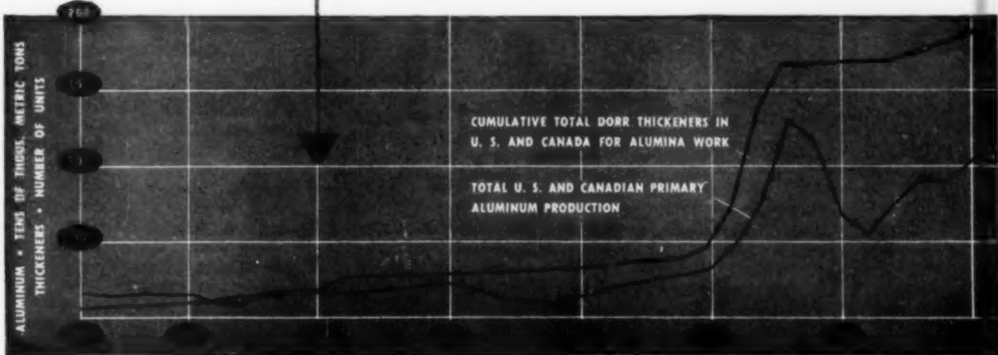
if it's

thickeners

you need... check the record of the

Aluminum

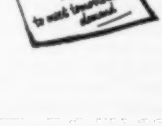
industry



1916 marked the installation of the first Dorr Thickener in the aluminum industry. Today, nearly 200 Dorrs... the majority big-capacity tray units... serve the industry in the United States and Canada alone. Elsewhere in the world, better than 200 additional units are installed for the processing of alumina prior to its reduction to metal.

We have gained invaluable experience in the handling of chemical processing problems from this long association. And the aluminum industry is but one of the many that pioneered with Dorr Thickeners... and has shown continuing faith in their use.

If it's Thickeners you need, regardless of size, type or use, it will pay to check Dorr... the oldest manufacturer of sedimentation equipment *with the newest ideas.*



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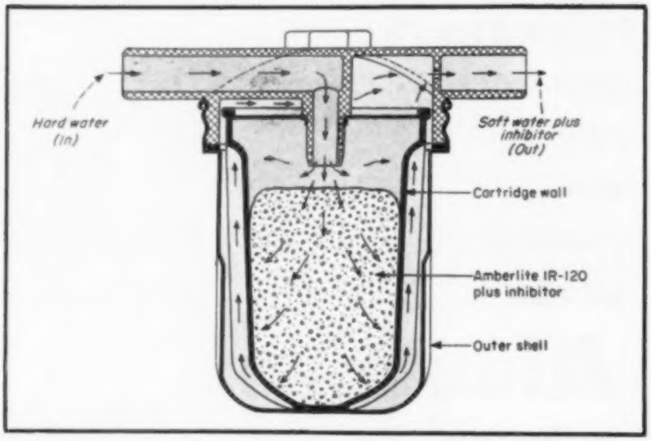


To fight corrosion in cooling systems, new unit uses ion exchange resins.

Boost For Ion Exchange Resins

Mass distribution of new unit to soften water in cooling systems in cars, commercial vehicles and homes would result in an impressive new outlet for ion exchange resins. (194A)

A new automobile accessory protects cooling systems against scale and corrosion by softening the water with ion exchange resins. This unit, which removes calcium, magnesium and other troublesome ions from the circulating cooling water, puts under the hood of the family automobile a miniature water softener that could result in a sizable new demand for ion exchange resins.

Four million pounds of resin would be required annually for replacement cartridges alone, if the softener is installed in 30 percent of the 55 million vehicles and tractors in America. But mass distribution of a simple, effective automotive unit may have even broader consequences for the chemical industry. If the car owner is shown that hard water is a serious hazard to the cooling system of his car, it should not be difficult to extend his thinking to the water supply in his home. This should add further impetus to the rapidly growing market for household softeners.

The heart of the automotive exchanger, produced by the Fram Corp. of Providence, R. I., is the replaceable cartridge. The cartridge, inserted in an outer sheet-metal container, consists of two functional elements: a mixture composed of 2 oz. of Amberlite IR-120 cation exchange resin and a corrosion inhibitor, sealed in a polythylene-treated cloth sack; and the cartridge shell, molded from phenolic-impregnated paper. For buffering purposes, the inhibitor, sodium mercaptobenzothiozole, is combined with sodium borate. The resin, manufactured by the Rohm & Haas Co. of Philadelphia, is dried to well below a 30 percent moisture content to facilitate uniform mixing with the inhibitor.

Circulating coolant water, by-passed from the main stream of the heater line, enters the top of the unit and flows into the sack containing the exchanger-inhibitor mixture. There, calcium, magnesium and other ions are adsorbed by the resin. The processed water picks up the inhibitor-borax mixture, passes through the fine-pored walls of the cartridge, where particles of rust and scale are filtered out, and returns to the cooling system. The flow through the unit is 24 qt. per hr. at road speeds of 30-40 mph.

Residual carbonate and bicarbonate ions from the raw water plus the borate ions introduced from the exchanger sack keep the pH of the cooling system buffered at 7.5 to 9.0, the most favorable pH range for inhibiting corrosion. Uniformity of pH was confirmed by sampling 160 vehicles throughout the country whose radiator water, of widely varying initial pH, had been treated by the softening unit for periods of from six to twelve months.

The Amberlite resin is compatible with standard anti-freeze materials and rust inhibitors, including the soluble oil type inhibitor, used in automotive cooling systems. Moreover, the resin shows no physical or chemical degradation from heated coolant even after prolonged engine operation. In fact, during the manufacture of an experimental filter unit, a batch of the Amberlite IR-120 resin was inadvertently baked at 400 deg. F. in a paint drying oven with no apparent effect on resin efficiency.

The 2-oz. charge of resin in the cartridge has the theoretical capacity to remove 500 ppm. of ionic solids (as calcium carbonate) from 4 gal. of water—the average capacity of pleasure-car cooling systems. Since hard water in this country rarely contains more than 300 ppm. (as calcium carbonate), the cartridge provides the user with a 40 percent reserve capacity to process water added to replace losses from leakage or evaporation. To prevent loss of efficiency from the accumulation of rust and scale on the porous cartridge surface, the manufacturer recommends that the cartridge be replaced twice a year.

Aluminum Colorant

One operation which permits protection and dyeing to such colors as blue, green, gold, brass. (194B)

A new chemical process for protection and coloring of aluminum has been developed by Enthone, Inc., New Haven, Conn. It is said to work effectively on almost all aluminum alloys and on large as well as small objects.

The process is called Alumox 44. It consists of cleaning the aluminum part and then immersing it in a solution of Alumox 44 salts. Dyes can be added to the solution so that coating and dyeing occurs simultaneously.

To reduce finger marking and pro-

tect the aluminum against weathering, clear coatings can be produced. The coatings are relatively nonconductive and have a thickness of approximately 0.0001 in. However, the process is not meant to be a substitute for electroanodizing. In most cases the finish is covered with clear lacquer.

The Alumox 44 salts are available as a powdered material which is added to water in a concentration of 1 lb. per gal. The bath operates in the temperature range from 190 to 210 deg. F. Coloring is accomplished in from 15 sec. to 2 min.

IN BRIEF—A capsulated listing of this month's newsworthy products

Don't Forget: Reader service postcard inside back cover will bring you more information. Use these key numbers.

Polyester Film

With high dielectric and mechanical strength, long-term resistance to heat, chemical inertness. (195A)

All indications are that Du Pont's new Mylar will find major uses for which cellophane and other commercial films are not suitable. The most promising immediate field appears to be electrical insulation. After additional research and development, it is likely to go into the industrial tape field to widen the use of film-based tapes. It is also expected to be combined in laminations with other materials. Additional uses may include packaging and collapsible tubes.

It is being produced experimentally by Du Pont's film department on semi-works equipment in Buffalo, N. Y. The film is being evaluated in a number of industrial fields but it will be several years before it is generally available commercially.

Besides having most of the best properties of other commercial films (it looks like cellophane), Mylar has several unique properties. One is high strength, from two to eight times that of other commercial films. This makes possible thinner gages, about a third as thick as the thinnest commercial films produced by Du Pont in the past.

A second property is its ability to retain dimensions and properties through a wide range of heat and cold. A third is intermediate electrical polarity. This permits it to store electrical energy, a requirement for use in condensers. Also, it has high dielectric strength, or insulating power, without excessive power loss —properties required for conductor insulation.

Mylar now sells for $3 to $4 a lb., depending on thickness. Reduction in price, like widespread use, awaits large-scale production.

Mylar is a condensation polymer obtained from ethylene glycol and terephthalic acid. Thus, it is chemically similar to Du Pont's newest textile fiber, Dacron polyester fiber. Dacron is spun whereas Mylar is cast in continuous sheets. It is also chemically similar to the company's recently announced polyester base for photographic film of superior toughness.

Fluorochemicals

Two intermediates for the preparation of new types of organics containing stable fluorocarbon groups. (195B)

The world's first unit for the electrochemical manufacture of perfluorinated compounds is now turning out ton lots of trifluoroacetic acid and perfluorobutyric acid. The manufacturers, Minnesota Mining & Mfg. Co., are seeking to open up new types of markets based on the unique properties of fluorochemicals.

Trifluoroacetic is a strong, nonoxidizing acid. All the metallic salts so far studied have been soluble in water. Thus, the trifluoroacetates provide a means of obtaining stable, nonoxidizing solutions of difficultly soluble metallic ions. These facts made it particularly useful in metallurgical and analytical applications.

It has been used in the preparation of vinyl polymers. Polyvinyl trifluoracetate has been used in lacquers, varnishes, adhesives for wood, metals and glass, for wrapping material, and, if pigmented, for coating compounds.

As an acidic condensing agent, it sometimes excels sulphuric acid and aluminum chloride because oxidation and rearrangement side reactions do not take place. Condensation of acetic anhydride with anisole using trifluoroacetic acid as a catalyst produced p-methoxyacetophenone in 91 percent yield.

Trifluoroacetic anhydride has been found to be an effective esterification promoter. In reactions between an alcohol and an acid, the addition of trifluoroacetic anhydride in an amount equivalent to the alcohol has been effective in esterifying carboxylic acids in both the aliphatic and aromatic series. In many cases, the reaction proceeds spontaneously and is essentially complete in a few minutes. Reaction conditions are mild. They enable acetylated derivatives to be prepared in good yield from acid-labile glycosides. The method is particularly convenient for the acetylation and benzoylation of polysaccharides and for the production of polyesters. The resulting trifluoroacetic acid can be separated from acetic acid with moderate ease, and readily distilled from solution of higher boiling acids.

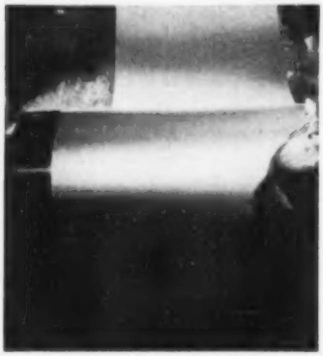
The trifluoroacetamido group has been used in the preparation of fluorinated azo dyes for cellulose derivatives, silk, wool, nylon. Trifluoroacetic acid has catalytic activity when used as a nitrating medium. It has been found to accelerate the rate of nitration of toluene.

Potential customers for the second new fluorochemical, perfluorobutyric acid, are paying particular attention to its low surface tension and therefore its high penetrating power. There's also interest in the strong acidity of the compound coupled with its nonoxidizing and nonoxidizable nature and in the possibility of introducing the hydrophobic perfluoropropyl group into organic molecules.

The common salts of the acid are unusually soluble in water. Since the acid is strong, salts of strong bases are hydrolyzed very little.

Both of the new acids are very hygroscopic. Sample shipments are made in glass bottles sealed with polystyrene caps containing a Teflon liner. Closures such as cork, rubber,

bakelite, and polyethylene are all attacked by the acid. Low surface tension makes tight sealing difficult, as the acid tends to creep. Current prices are $5 per pound for trifluoroacetic and $15 for perfluorobutyric.



Tiny particles of mica make strong sheet.

Mica

New processing development makes a superior form of this strategic material obtainable from domestic sources. (196A)

New laminates, tapes and molded shapes for electrical equipment are foreseen thanks to a new GE process for producing mica in continuous sheets. These sheets have better dielectric strength than present machine- and hand-laid mica products. Greater uniformity of thickness and absence of voids account for its improved properties.

Sheets ranging from 0.002 to 0.006 in. thick are made by treating mica flakes so that a force is generated which holds the tiny particles together. Referred to as GE micamat, it is being pilot-planted in the company's Pittsfield, Mass., laboratory. Commercial production is planned for the first quarter of 1952 at the Coshocton, Ohio, plant.

Micamat tapes and sheets are capable of being impregnated with resins and bonded to paper, glass and cloth for greater strength and improved electrical properties. They can be used in heating devices, molded into shapes for motors and generators or machine-wrapped on bars and cable.

Heretofore, imports of mica from India accounted for the majority of it used by our electrical industry because of the inferior quality of American supplies. Now, production of micamat may necessitate the reactivating of U. S. mica mines. It is probable that as production of micamat expands, cost savings will result.

Plastic Resins

Withstand prolonged temperatures up to 500 deg. F. (196B)

American Cyanamid has developed three new polyester resins based on its newly developed monomer, triallyl cyanurate (CE, Feb. 1952, p. 229). The resins will be marketed as PDL 7-669, a general purpose resin, PDL 7-680, a fire resistant (self-extinguishing) resin containing antimony trioxide, and PDL 70679, a crystalline resin for impregnating mat or cloth.

Reinforced by glass cloth, the new resins will give flexural strength values during exposure at 500 deg. F. of from 30,000 to 35,000 psi. They lose virtually none of their strength after more than 24 hr. of continual exposure at this temperature. The best competitive heat-resistant polyesters showed strengths of only 15,000 to 20,000 psi. upon initial exposure to 500 deg. F. The new products should find use as light-weight, heat resistant airplane parts, as durable oven-wear and in similar places where plastics currently available cannot be used.

Rust Remover

For steel, cast iron, malleable iron and other ion alloys. (196C)

A new alkaline derusting process has been developed by Enthone, Inc., New Haven, Conn. It is unique in that no acid is required throughout. Attendant advantages: elimination of subsequent rusting; no attack on the base metal; speed of operation.

The salts making the derusting bath are sold under the designation, Enthone Derusting Compound 134. They are supplied as an alkaline powder in steel drums.

Because the process is alkaline in nature and contains detergent materials, it simultaneously cleans and derusts. The solution can be operated in a steel tank at room temperature. The work to be derusted is made the cathode in a solution of the derusting compound for from a few seconds to several minutes depending upon the condition of the surface.

Tests made comparing the speed of derusting with hot sulphuric or cold hydrochloric acids have shown that the new process takes only a fraction of the time. In one test, complete rust and scale removal was accomplished in 2 min. as against 45 min. for acid pickling.

The process is applicable for derusting without a heat source being available. A complete setup can be made by means of a steel tank and a source of direct current. The container can be steel, stainless or even wood in case of an emergency. If protection of the object being derusted is desired, zinc can be incorporated in the bath to enable cleaning, pickling and zinc plating all in one tank.

Vinyl Resin Latex

Means grease-proofness, chemical and moisture resistance for textiles and paper. (196D)

An aqueous dispersion of a vinyl chloride copolymer is being produced by Goodyear Tire & Rubber's Niagara Falls subsidiary, Pathfinder Chemical Corp. Known as Pliovac Latex 300, it is the first in a series of new vinyl resin latices.

According to Goodyear, these latices will be less costly than other vinyl dispersions because they do not include volatile solvents. Processing problems of toxicity and flammability are eliminated. Another advantage is that water penetrates fibers more completely than other dispersing media so that a compound latex will form a very thin film of more complete continuity and with better adhesion to the fiber.

Pliovac Latex 300 imparts grease-proofness, chemical resistance and resistance to moisture to fabrics and papers coated with the material. Physical properties are also improved. Typical other uses are as pigment binders for inks and paints, as binders for nonwoven fabrics and felt, and as a sizing for textiles.

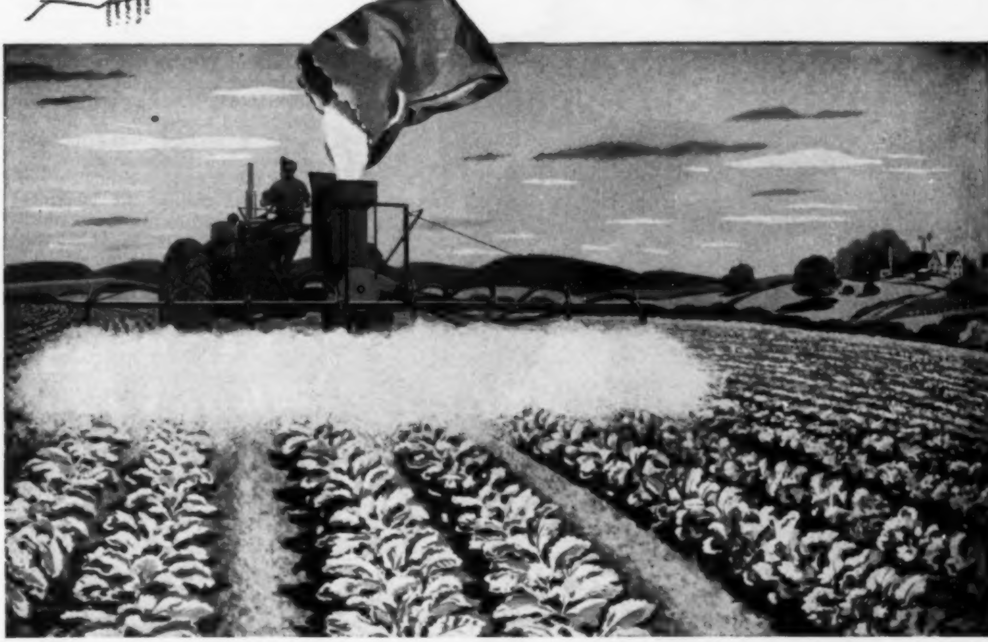
Neoprene Exterior Coatings

Protection against splash, spill and corrosive fumes and atmospheres. (196E)

Exteriors of tanks, process equipment, structural steel, pipelines and the like can now get protection from neoprene coatings made expressly for the purpose. The new film has neoprene's excellent resistance to acids, alkalis, oils, most hydrocarbons and to sunlight and weather.

Neoprene maintenance coatings are the result of two developments: a slightly modified neoprene polymer

How Celite Mineral Fillers give a product better dispersion . . .



Making a better "killer" of insecticides

To increase the effectiveness of their product . . . add more "killing power"—many leading producers of insecticides add Celite Mineral Fillers to their dust as a standard ingredient.

This use of these diatomite powders is based primarily on (1) their light weight and great bulk which improve dispersion of the poison, and (2) their high absorption capacity that produces dry dust concentrates from both low melting point solids and liquid poisons, thereby increasing the potency of the final product.

These and other unusual physical characteristics adapt Celite Mineral Fillers to numerous industrial uses.

CHECK LIST OF PRODUCT BENEFITS OBTAINABLE AT LITTLE COST WITH CELITE MINERAL FILLERS

- Added Bulk
- Better Suspension
- Faster Cleaning Action
- Greater Absorption
- Improved Color
- Better Dielectric Properties
- More Durable Finish
- Increased Viscosity
- Elimination of Caking
- Higher Melting Point
- Better Dry Mixing
- Improved Dispersion

THESE CELITE PROPERTIES BENEFIT MANY TYPES OF PRODUCTS

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MINERAL FILLERS

which, before vulcanization, produces solvent solution of low viscosity per unit of solids content; accelerators which will cure this polymer at room temperature. Main ingredients of the coating are an aromatic solvent, carbon black, neoprene and a separately added accelerator. It dries by solvent evaporation and cures by polymerization of the neoprene.

The film is tough and rubbery and its resilient qualities are inherent—not the product of plasticizers which may volatilize or leach out. Solids content is 60 to 70 percent yet it remains readily brushable while giving a thick film per coat. To be sure of good adhesion, surface must be thoroughly wire-brushed or sandblasted and a coat of primer applied.

The coating cures ready for service at room temperature in 24 to 48 hr. by the addition of an accelerator at the time of use. A second coat may be applied 2 or 3 hr. after the first without danger of brushing up the first. However, a fresh coat bonds well even to a fully cured prior coat.

Strontium Hydrate

For use in such fields as lubrication, plastics, carbohydrate purification and refining. (198A)

Pilot plant quantities of strontium hydrate are now being made by Westvaco Chemical Division.

A wide variety of strontium greases can be produced from strontium hydrate and various soap stocks. A number of properties make these greases particularly useful. They can be heated and cooled continuously in service without any substantial change in consistency. They also resist the disintegrating effects of water at ordinary or elevated temperatures and the leaching action of hydrocarbons. They offer: superior protective action against moisture or salt spray corrosion; resistance to oxidation or breakdown upon exposure to elevated temperatures; good stability of grease structure when subjected to mechanical working.

Strontium napthenate and a number of other soaps of this type are useful stabilizers for many vinyl plastics. Coal tar, resin and long chain aliphatic acids can be reacted with strontium hydrate to form such stabilizers.

Strontium hydroxide has been used quite extensively in Europe for the refining of beet sugar. It forms an insoluble disaccharate with sucrose which may be separated and refined. The sucrose can then be regenerated

by the addition of carbon dioxide which forms insoluble strontium carbonate. Such complex formation also occurs with other polyhydroxy materials such as glycerol and mannitol. For this reason strontium hydrate may find considerable use in the refining of special carbohydrate-like materials.

Various salts of strontium have been used with considerable success as additives for ceramic glazes. Strontium hydrate, of course, provides a convenient method for preparing various strontium salts, for example, strontium bromide. It has also been used to improve the drying characteristics of oils and paints.

Westvaco strontium hydrate consists of small white crystals; approximately 80 percent will pass through a 20 mesh screen. It comes in 400-lb. net wooden slack barrels.

Fungicide

Control for tomato and spud diseases. (200A)

Du Pont has just announced the sixth in a series of organic plant protectant materials. This one, called Manzate, is now available in limited quantities. Chemically it is ethylene bisdithiocarbamate.

As a chemical to control tomato diseases, Manzate fungicide offers a single treatment which is effective against all major fungous enemies of the tomato plant. Previously two or more chemicals have been required in alternate applications to control the various diseases. This ability to rely on one material relieves the grower of a critical problem of applying the right chemical at the right time to combat each disease.

As a potato fungicide, it has proven particularly effective in cases where both early and late blights were equally severe at the same time.

While Du Pont's recommendations for use of Manzate will be confined to applications on tomatoes and potatoes at present, further tests to control diseases on other crops will continue through 1952.

Resin

For application in products requiring resistance to water and aqueous solutions of acids, bases and salts. (200B)

A new low-priced thermoplastic resin is being made by Atlantic Refining Co. Called S.P. Asphalt Resin, it is produced from petroleum by a solvent process.

It is recommended for use in as-

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Soaps
Soft Drinks
Sugar
Textile Processing
Tooth Powder & Paste
Water Proofing
Water Treatment

phalt tile, for internal sizing of Kraft paper, sealing compounds, adhesives, for water-proofing, as a tackifier for synthetic rubbers, and as a plasticizer and extender for rubber compounds. Since the product is a dark colored neutral hydrocarbon material, it is unsuitable for those applications where light color is important.

It is essentially ash free and contains no free carbon. It is odorless and has low volatility which makes it suitable for application at high temperatures. It is generally compatible with petroleum oils, asphalts, pitches, vegetable and fatty oils, oil soluble alkyd resins, other hydro-carbon resins and several rubber types.

Air oxidation of the resin at high temperatures converts it to a product similar, in some respects superior, to natural Gilsonite. Because the resin source is constant and the oxidation process can be very closely controlled, the resultant synthetic product is uniform in quality. The oxidized resin is now available in experimental samples. Suggested uses are in the manufacture of molded products, paints and varnishes, rubber compounds and mastics.

Alkyd plasticizer, claimed to yield light colored and even clear baking enamels that are entirely heat-stable, has been patented. It is said to be especially suitable for use in coating compositions containing urea-formaldehyde and melamine-formaldehyde resins. Components: phthalic anhydride; glycerine; either capric acid or 2-ethyl hexoic acid. *(202A)*

Two acrylic thickeners, just put on the market by American Polymer Corp., are aqueous solution of sodium polyacrylate. They are recommended primarily as stabilizers, protective colloids and thickeners for natural, synthetic rubber and resin latices. Polyco 296BT is a high-viscosity grade and Polyco 296N is a medium-viscosity grade. *(202B)*

High soap and alkali resistance, color retention and film uniformity are claimed for Rohm & Haas' new alkyd-modified, triazine-fornaldehyde resin. Designated as Uformite M-311, it is compatible with short oil alkyds of the oxidizing and non-oxidizing types generally used in white baking enamel formulations. *(202C)*

Sealer for gaskets and threaded joints—a nonsetting compound of microfine metallic lead and non-drying insoluble oil—has been announced by Chicago Gasket Co. *(202D)*

CE's Guide to

NEW TECHNICAL LITERATURE

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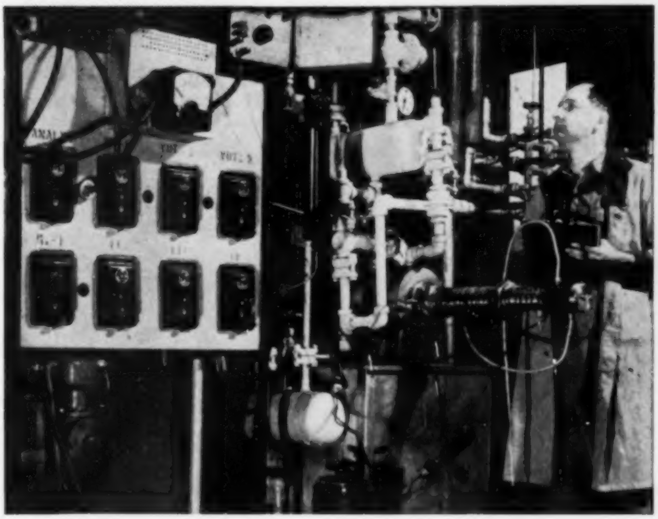
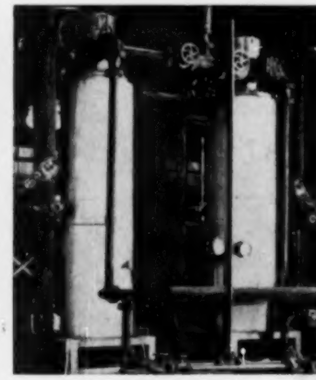
Girdler Process News





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GIRDLER provides complete engineering service on heat-transfer problems

OPERATING on a continuous, closed-system basis, VOTATOR* Heat-transfer Apparatus achieves from six to ten times higher rates of heat transfer than are obtainable with conventional heat exchangers. This equipment is widely used for heating or cooling, crystallizing, controlling heat of reaction, and many other processes.

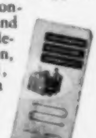
Girdler's pilot plant and laboratory facilities are utilized constantly for the development of new processes and equipment, or are available for special research on new processing applications.

Girdler's Process Engineering Group includes a large number of specialists: architects, cost estimators, and chemical, mechanical, electrical, structural, and instrumentation engineers. Outstanding Girdler chemists and engineers in the fields of oil processing and food technology have developed distinctive processes and apparatus for many plant operations: cooking, cooling, plasticizing, bleaching, hydrogenating, winterizing, deodorizing.

Call on Girdler in the planning stages of *your* processing facilities. You can do so with confidence.

WANT INFORMATION?

Girdler's Votator Division designs and builds complete plants for processing edible oil, food, and many other products; and supplies heat-transfer equipment for continuous processing of liquid and viscous materials. Write for Bulletin V-48. The Girdler Corporation, Votator Division, Louisville 1, Kentucky. District Offices: San Francisco, Tulsa, Atlanta, New York. In Canada: The Girdler Corporation of Canada Ltd., Toronto.



SALES APPEAL—The tremendous appeal of frozen concentrate juices is based on protection of delicate flavor and vitamin content. Processing in a fully enclosed system excludes air. Thus oxidation is minimized and purity assured. VOTATOR Heat-transfer Units at Minute Maid Corporation convert concentrated juices to a sherbet-like ice, in just a few seconds. The automatic, closed-system process assures product uniformity.

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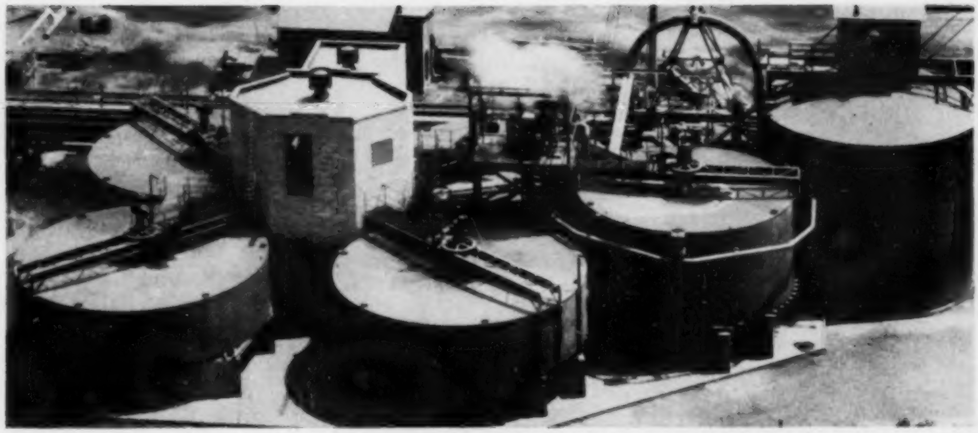


Counter-current decantation system for leacher recovery. From right to left: storage, green liquor clarifier, washers.

Carbon Recovery From Black Ash

A CHEMICAL ENGINEERING PICTURED FLOWSHEET

In papermaking, "black liquor" is the liquor formed after cooking pulpwood with an alkaline liquor by either the soda or sulphate (kraft) process.

At the Covington, Va., mill of the West Virginia Pulp and Paper Co., leacher (carbon from leached black ash) is recovered from black ash (incinerated black liquor). Green liquor from the black ash leaching is recausticized for re-use as cooking liquor. The leacher is converted to "Nuchar" activated carbon, a valuable product for clarification and decolorizing purposes. The economics may sometimes dictate complete removal of the organic constituents of the black liquor during the incineration. West Virginia Pulp and Paper Co.'s mill at Luke, Md., for example, is now using a newer-type furnace which burns off all the carbon leaving essentially sodium carbonate. No carbon recovery system is involved here.

Rotary furnaces

The feed to the rotary furnaces at the Covington mill is concentrated black liquor, which has passed through multi-effect evaporators and then through cascade or other types of equipment to drive off a sufficient amount of water for efficient combustion.

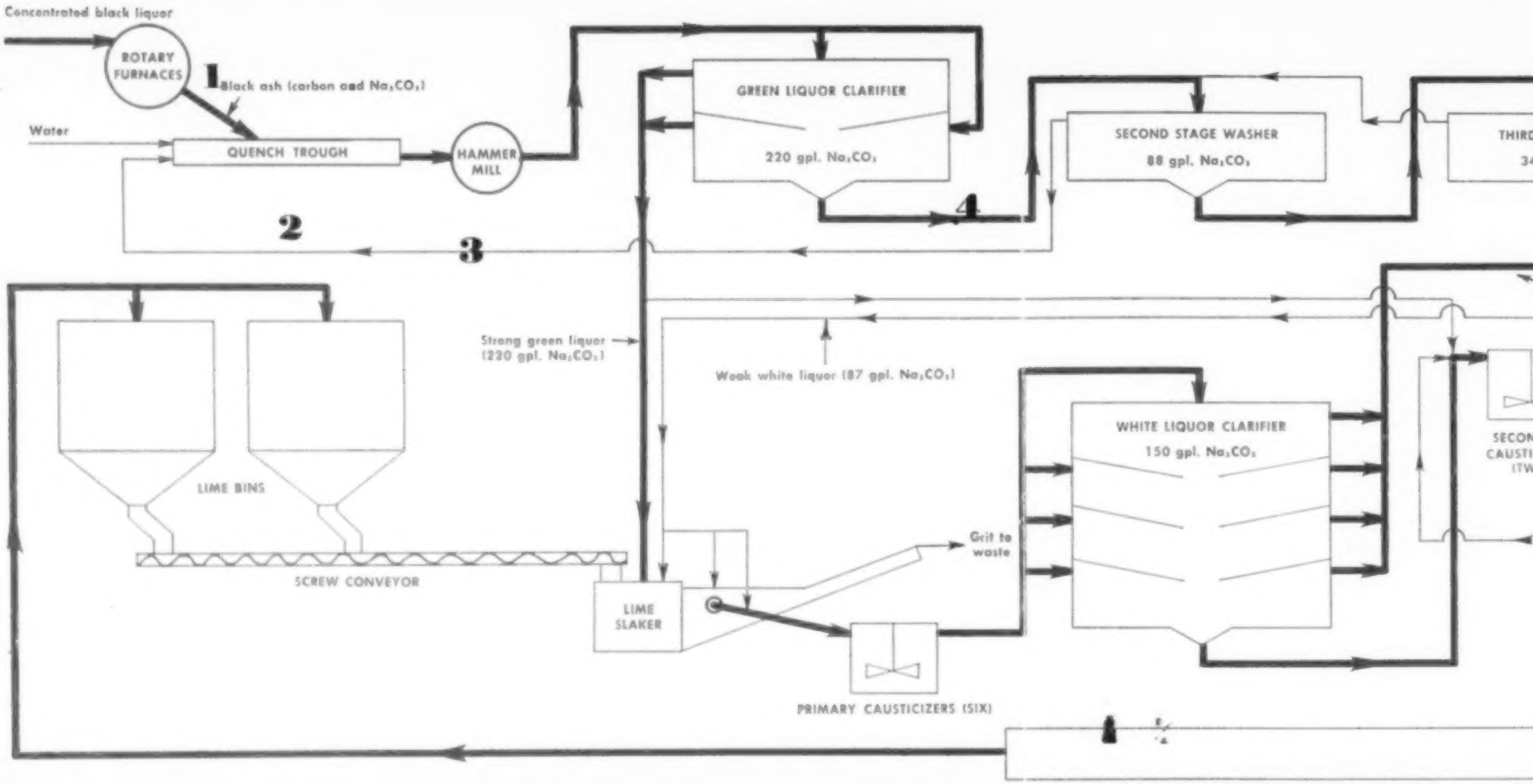
Prominent in both the carbon recovery and recausticizing operations at Covington are Dorr CCD (counter-current decantation) systems. Concentration of sodium carbonate* is reduced from 220 gpl. in the feed to the first stage of the carbon recovery CCD system to 1.25 gpl. in the sixth stage. Underflow dregs are transferred by Dorrco diaphragm pumps, while the overflows carrying some fines in suspension are circulated by Worthite-centrifugal pumps. Leacher leaving this system has only 1 percent sodium carbonate. This amount is further reduced in a similar CCD system in the carbon plant. A furnacing operation converts the re-washed leacher to the activated form. Capacity is 100 tons per day of black ash.

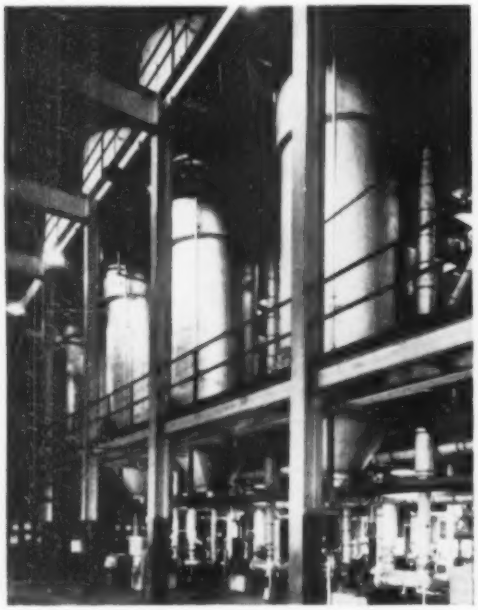
Older method

The older method of leaching black-ash employed fixed beds of the ash. For large operations this older method would be impractical and too costly.

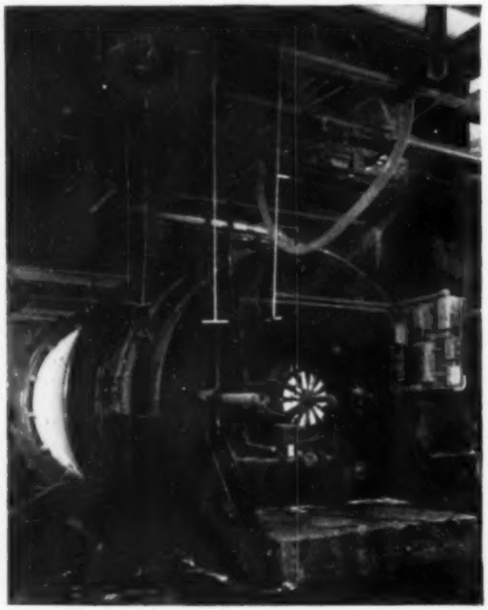
Recausticizing is done by chemically combining the recovered sodium carbonate (green liquor) with slaked lime. This forms caustic soda which is the cooking liquor in soda pulping. It also forms "lime mud" or calcium carbonate which is separated from white liquor, washed in another CCD system, then dewatered to 62 percent solids in centrifuges before calcining to quicklime. Soda (as Na_2O) on dry lime mud, is approximately 0.5 percent. Secondary causticizing takes place immediately following white liquor removal. The lime kiln is 350 ft. long, 11 ft. in diameter, and handles 275 tpd.

* Sodium carbonate as used in this article refers to all sodium compounds present expressed as equivalent sodium carbonate. In the leacher (top) washing circuit of the flowsheet sodium compounds are present as sodium carbonate and sodium sulphide. In the lower washing circuit, the sodium compounds are present as caustic soda, sodium sulphide, and a small amount of sodium carbonate.



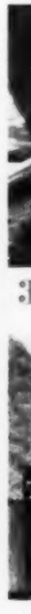


Multiple-effect black liquor evaporators, which concentrate the feed to the rotary furnaces for efficient combustion.



1 One of the rotary furnaces, which reduce the organic constituents of the black liquor to carbon.

2 Quenching trough, in which black ash from the rotary furnaces is quenched with water and weak green liquor.



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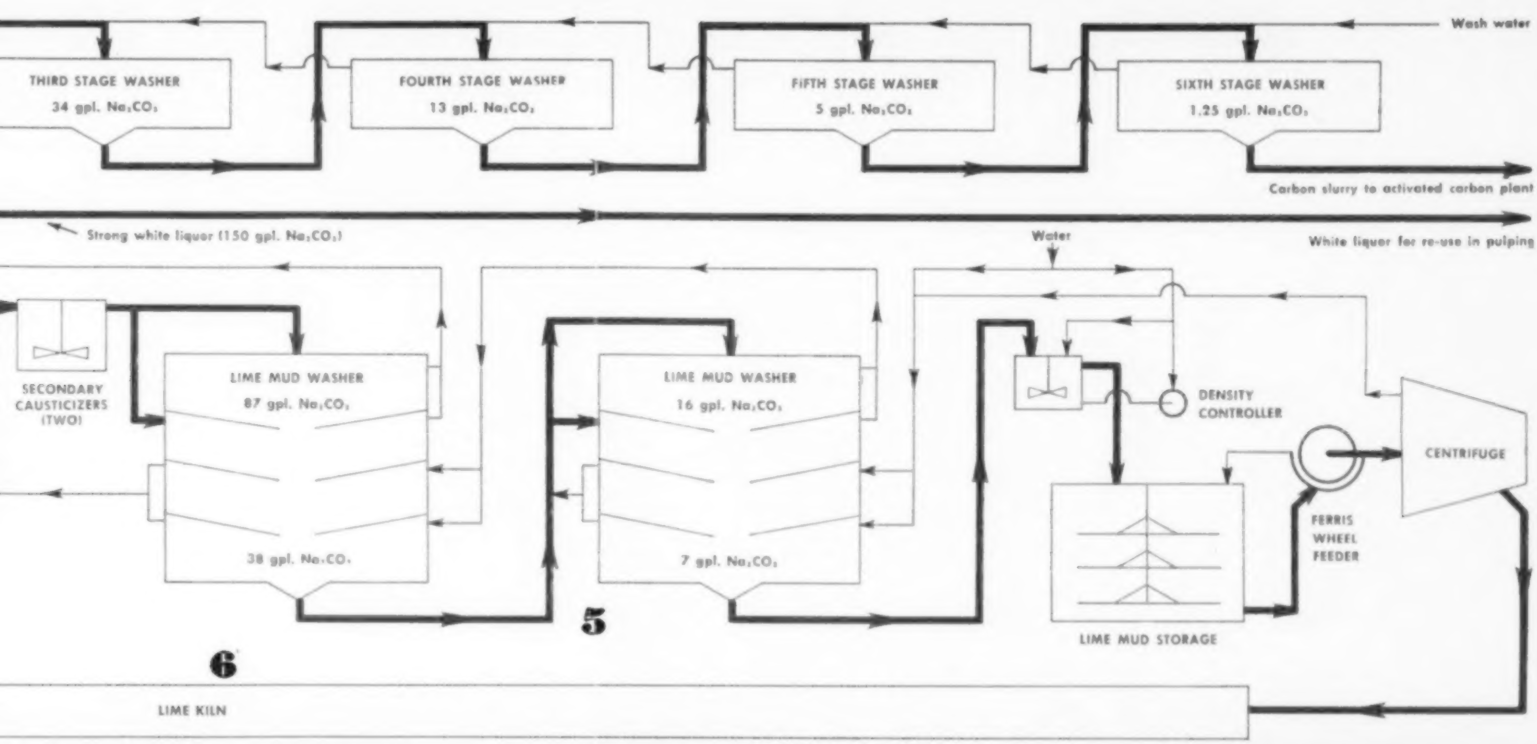
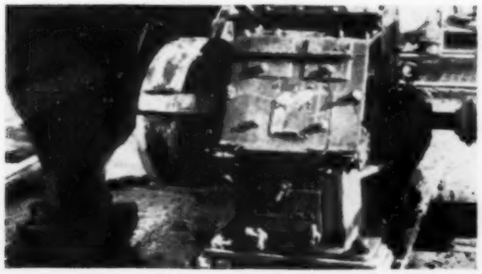




3 Hammer mill breaks up the quenched black ash to a size suitable for leaching in the green liquor clarifier.

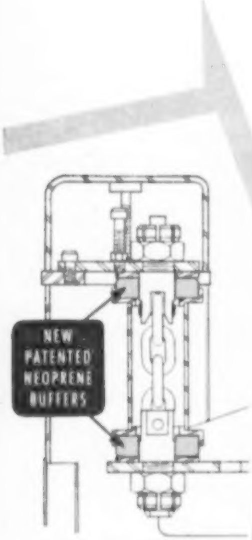
4 Green liquor clarifier (right), and second stage washer (left). Na_2CO_3 concentration starts its drop.

5 Counter-current decantation system for white liquor separation and lime mud washing. Dewatering is next.

6 Lime kiln which burns lime mud to quicklime for slaking. Slaked lime is for causticizing of green liquor.

NEW Centrifugal

SAVES TIME AND LABOR



IMPROVED PEDESTAL DESIGN CONTROLS VIBRATION

FEWER STOPS to rearrange load

Tolhurst "Center-Slung" Centrifugals, long famous for their exceptional stability, have now been re-designed to handle even greater out-of-balance loads.

Tolhurst "Center-Slung" Centrifugals have the case suspended by flexible chain links so that the revolving mass is free to find its own center of gyration, resulting in unusually smooth operation. Now, the chain links are housed in grease-packed metal sleeves and are mounted top and bottom in neoprene buffers to absorb vibration. Tests show that this improved Tolhurst "Center-Slung" can handle out-of-balance loads 3 to 4 times greater than ever before. Less care is needed in loading the basket and fewer stops are required to redistribute the load.

Other improvements include mounting the spindle in roller and double row ball bearings in a new type of tubular housing, a slanting case bottom for faster, more complete drainage, a new self-energizing brake and more compact motor mounting.

Machines are available with split cover or full cover and can be fume-tight construction. Basket, case and cover can be constructed of any practicable material, as specified. Single speed or two-speed motor drive, or infinitely variable speed hydraulic drive available. Basket sizes, 12" through 108" in diameter.

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EAST MOLINE, ILLINOIS

piping upkeep

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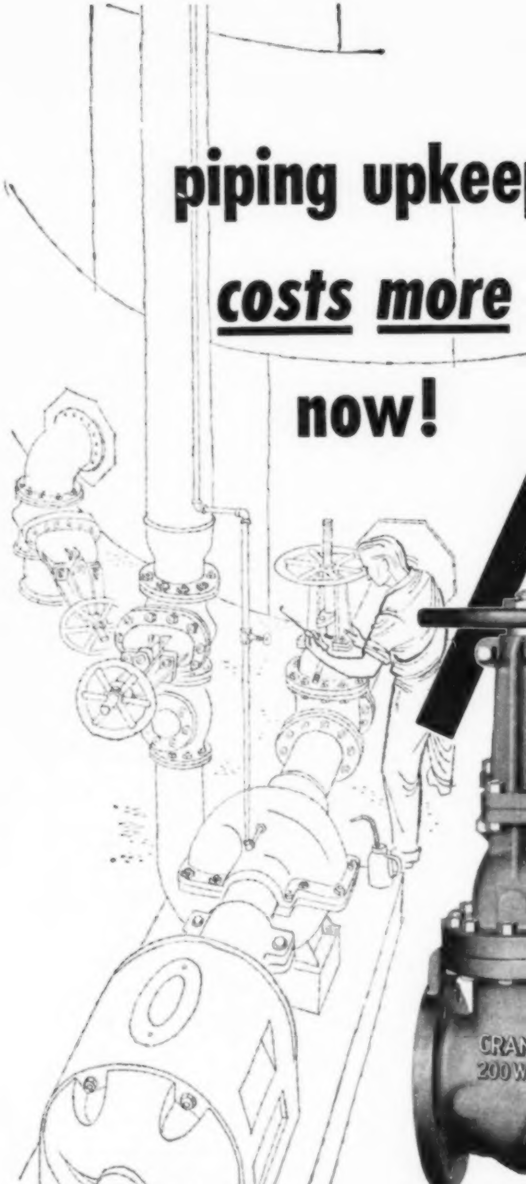

Crane Alloy Cast i
18-8 Mo. trimmed. 2

CRANE C

VALVES · FITTINGS · PIPE

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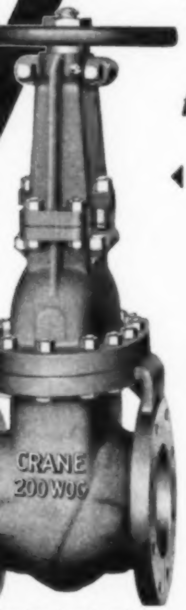

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You'll spend less for it with Dependable Quality

CRANE VALVES

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◀ High Corrosion Resistance at Low Cost

Crane No. 14477 Alloy Cast Iron Gates give excellent service where "all-iron" or "brass trimmed" valves fail, due to corrosion of seating surfaces. Body rings, stem, and disc-faces are Crane 18-8 Mo. Conditions permitting, these valves, with low nickel alloy cast iron body, are ideal substitutes for hard-to-get, more expensive, all 18-8 stainless steel valves.

O.S. & Y. design keeps stem threads from contact with line fluid; straight through ports assure unrestricted flow, minimize turbulence and corrosive action. Extra-long guides keep disc travel true.

Your Crane Representative will gladly show you why Crane Valves give better performance at lower ultimate cost—why you should insist on Crane Quality.

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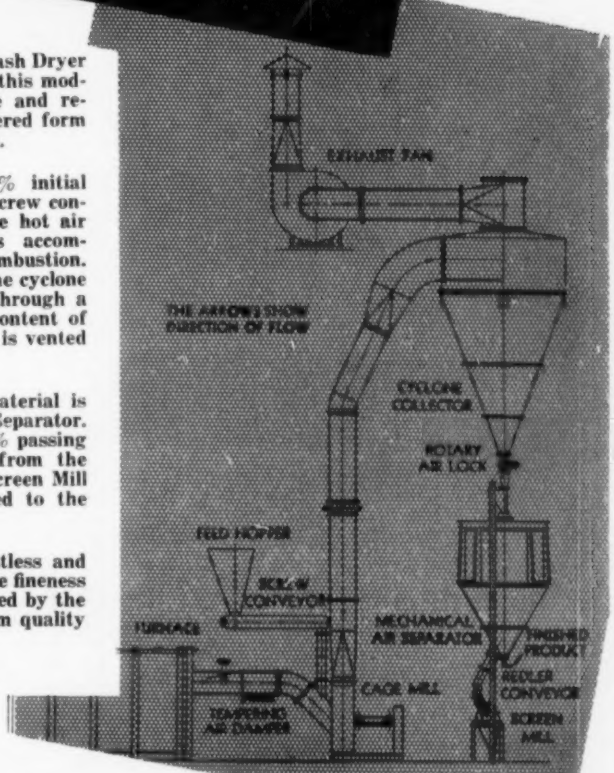
ANOTHER FIRST FOR *Flash Drying*

THE application of the Raymond Flash Dryer to STARCH is another example of this modern method of removing moisture and reducing the material to finely powdered form in a single, simultaneous operation.

Centrifugal starch, averaging 38% initial moisture, enters the Cage Mill by screw conveyor, where it is dispersed in the hot air stream. Instantaneous drying is accomplished, using direct products of combustion. The dried material is conveyed to the cyclone collector, where it is discharged through a rotary valve at a final moisture content of 12%, while the moisture laden air is vented from the system.

From the cyclone collector, the material is fed to a Raymond Mechanical Air Separator. It is classified to a fineness of 99.5% passing 200 mesh or finer. The tailings from the Separator are fed to a Raymond Screen Mill for further grinding, and returned to the Separator by a Redler conveyor.

The entire operation is clean, dustless and automatic. The close control over the fineness and dryness of the material, provided by the Raymond system, insures a uniform quality starch product.



Write for RAYMOND Flash Drying CATALOG No. 54A

Flash Drying is applicable to many other materials. If you have a drying-grinding problem, Raymond engineers will be able to help you.

Flow Diagram of a Raymond installation for Flash Drying STARCH at the Hammond, Indiana, plant of American Maize Products Company

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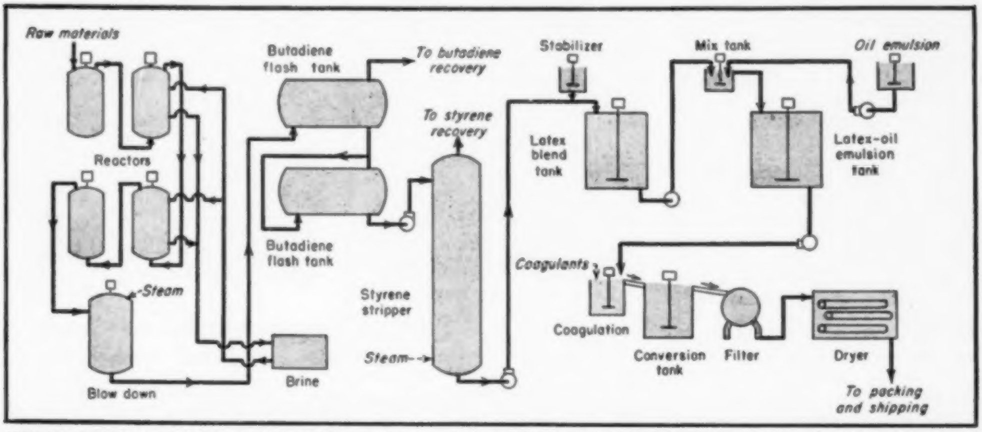
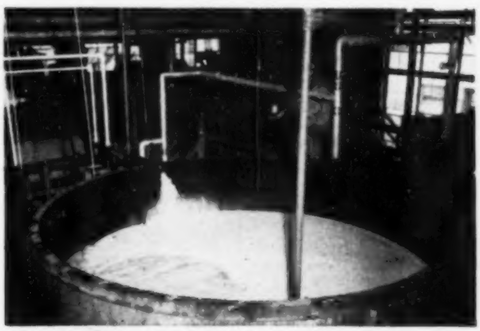
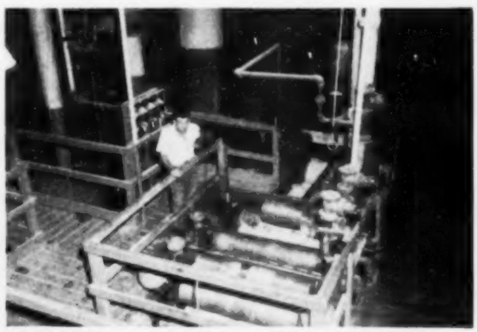


INNOVATION of extending synthetic rubber with oil emulsion will be installed in most government-owned plants by spring.



OIL EMULSION looks like this before it is added to latex.



FILTERS: coagulated latex-oil mixture is dewatered here.

New Process Adds 25 Percent More Cold Rubber

It's done by extending rubber latex with cheap petroleum. Output is up, cost is down, quality is unchanged. So far nine plants are installing the process.

Cold rubber was a "hot" new development a while ago. But instead of coming to rest, rubber technology has bounced up again with another major achievement.

Cold rubber oil master batch is its name and all it means is that a cheap petroleum-base oil is mixed with synthetic rubber latex without impairing product quality—something considered impossible a few years ago.

▶ **Why It's Cheaper**—The process uses 25 parts of oil to 100 parts of rubber. On a grand scale, that means gross output goes up 25 percent without building a bigger plant or using a drop more of scarce butadiene or styrene. Oil is cheaper than either of these monomers so costs drop too—about 4 c. per lb. of rubber (from 26 to 21.8 c.).

Timing of the new development was just about perfect. A short while ago, the rubber people had asked the Synthetic Rubber Division of RFC to supply 860,000 long tons of GR-S. At the time, production capacity of all plants was 760,000 tons. Now the 25 percent boost will meet the 860,000 figure with 90,000 tons to spare.

▶ **Process Is Modified**—Early steps of commercial cold rubber processing aren't changed. (*Chem. Eng.*, April 1950, pp. 102-105; 176-179). Styrene, butadiene and the other materials are prepared and pumped to a charge header. Reactors convert 60 percent of the monomers to polymer. In this polymerization step, the rubber hydrocarbon in latex form is reacted to a higher molecular weight by reducing the amount of modifier (a tertiary mercaptan) used.

No other change is necessary in this step of the normal process. The latex

mix (emulsion of water, rosin and fatty acid soaps, butadiene, styrene, mercaptan modifier, organic peroxide catalyst and ferrous sulphate-potassium pyrophosphate activator) is reacted to the same conversion level and in the same reaction time as any standard cold rubber latex.

This latex is sent through the recovery unit to salvage the unreacted butadiene and styrene; these are later blended with incoming fresh monomers.

▶**Oil Is Added**—The stripped latex (free of unreacted monomers) is stored in 30 to 70 thousand gallon blend tanks where a stabilizer is added.

Normally, the next step is the coagulation of the latex with salt and acid, but now the oil addition step is interjected. The oil is added to the latex as an emulsion (60 percent oil and 40 percent water with sodium oleate as the emulsifier) in a small mix tank. This latex-oil emulsion mixture is then coagulated with an acid brine solution.

Coagulated polymer is dewatered and a hammer mill breaks the cake into crumb. The crumb is dried and baled. Oils used as extenders have been described as processing oil; both naphthenic and aromatic types have been used successfully.

The latex of the higher molecular weight if coagulated would yield a rubber of a very high raw viscosity. This would be a tough rubber and one difficult to handle. But addition of an oil of a lower molecular weight brings the average molecular weight back to the range of standard cold rubber.

Quantity of oil needed amounts to 25 parts on 100 parts of rubber. Result: the tremendous increase in gross production.

▶**Everybody's in the Act**—Goodyear Tire & Rubber Co. was one of the first to get into production of oil master batch, promptly offered the process to RFC's Synthetic Rubber Division. RFC accepted and conversion got going in the Goodyear Synthetic Rubber Corp.'s RFC plant at Houston. In March 1951, commercial production was under way. By October, plant capacity was 5,000 tons per month and in seven months of operation 20,000 tons have been produced.

Other rubber companies are busy too. General Tire & Rubber Co. tried to sell the oil-rubber process to RFC in the fall of '50, got turned down, subsequently took the process to Canada. A Canadian-government-owned plant—the Polymer Corp. at Sarnia, Ont.—has since worked out large-scale commercial production. RFC's Baytown, Tex., plant, operated by General has also begun production.

B. F. Goodrich Chemical Co., operating the RFC plant at Port Neches, Tex., plans to convert one-fourth of the plant to the new type of cold rubber. The Copolymer Corp. plant at Baton Rouge, the Phillips plant at Borger, Tex., the Midland Rubber plant in Torrance, Calif., and the Firestone Tire & Rubber Co. plant at Lake Charles, have made trial runs.

RFC's plant at Port Neches, Tex. (run by United States Rubber Co.), will probably be in the program as soon as the low-temperature polymerization plant modification has been completed.

▶**The Rubber's O. K.**—Road tests have demonstrated that automobile tire treads made of cold rubber oil master batch are the equal of treads made of the original cold rubber formula. It's also satisfactory for other applications.

Try Formaldehyde Process For Refining Gasoline

Conventional methods for removing impurities from cracked gasoline components and blends have always had their shortcomings. Sulphuric acid treating, for example, reduces the octane number, has losses due to sludge formation, develops byproduct disposal problems, creates cost and scarcity of sulphuric acid during a sulphur shortage.

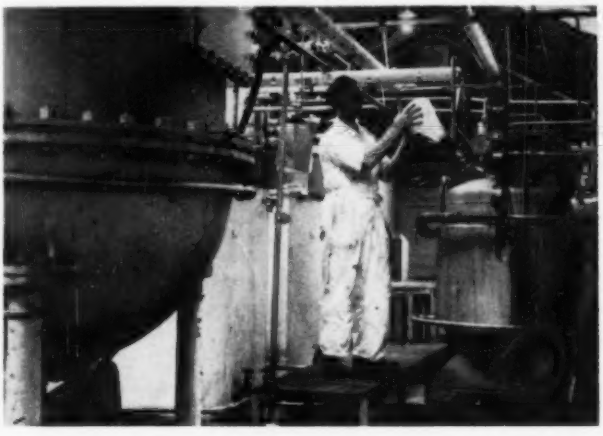
A new process, which uses formaldehyde as a refining agent, gives a more selective refining and eliminates many disadvantages of acid treating, according to Standard Oil Development Co.'s Esso Laboratories. Result is a better automotive and aviation fuel giving improved engine performance and less engine corrosion.

In this thermal treating process, gasoline is heated with 0.5-2 percent formaldehyde for 0.5 hr. at 250 deg. C. Gasoline loss ranges between 1-1.5 percent; in acid treating, 5.4 percent.

Suggest Minimum Salaries For Canadian Engineers

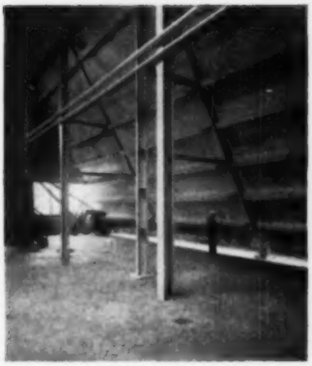
If industry follows the recommendation of the professional engineers associations of Quebec and Ontario, Canadian engineers will receive a guaranteed annual minimum salary.

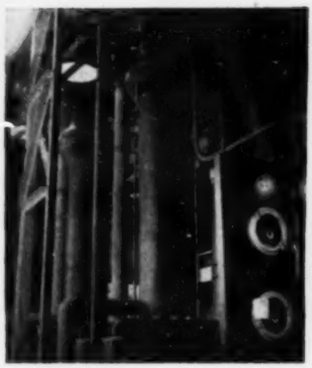
Engineering graduates with no experience will get a low of $3,200. An engineer with four years' experience and with one or more assistants, $4,800. The head of a division containing more than one department who has 21 years' experience, $17,800.

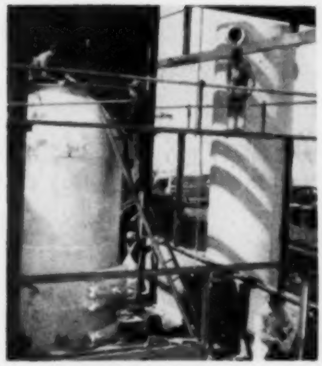


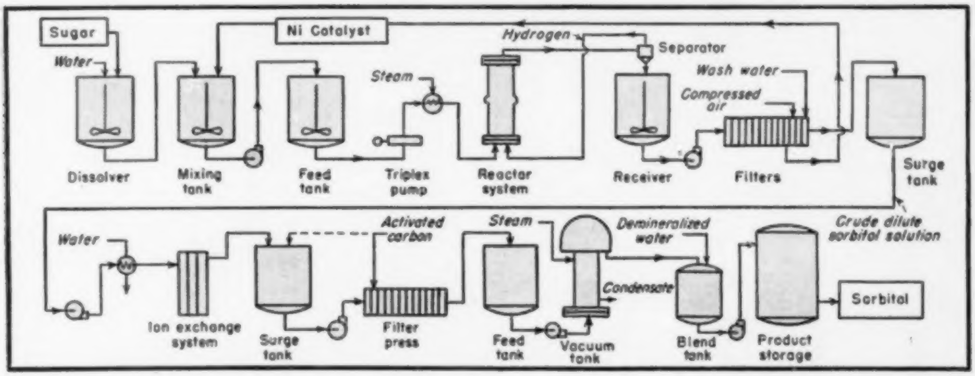
PLASMA SUBSTITUE NOW MADE IN AFRICA

Large new plant in South Africa is producing dextran, a blood plasma substitute. It is the second such plant of Messrs. Dextran Ltd.; the first is in England where the manufacturing process was developed. They make Dextran, a fermentation product of beet sugar, by isolating the so-called Birmingham strain of bacteria. Slimy liquid developed in culture flasks is transferred by a technician into big seeding tanks (see cut of British plant). For this he must use sterile, airproof innoculators as entrance of foreign bodies would make the product useless. Sterile air pressure within the 50-gal tanks insure that any leakage will be outward. Cultures go on to much larger stainless tanks for final fermentation.


Sugar storage.


Reactor system.


Plant construction.



Sorbitol Hits a High Stride

Improved process turns out a bigger volume of a better product at a lower cost. Availability—up ten-fold in three years—now nears 75 million pounds a year.

Among the polyhydric alcohols,* sorbitol's recent rise has been the most striking. And Atlas Powder Co., prime domestic producer, feels that this is only the beginning for its versatile polyol.

At least four factors back up this recent surge in the output and use of sorbitol:

• With the exception of anti-freeze—and possibly hydraulic fluids—sorbitol is finding a niche in all of the other polyol end uses. To top this unique versatility, it has cut out its own special and exclusive markets.

• While the price of other polyols has gone up—and may well continue doing so—the price of sorbitol has gone down. It now has the edge on most competitive polyhydric alcohols.

• Sobitol's availability† has been upped 10-fold since 1950, now can hit close to 75 million pounds annually. And Atlas can increase this readily, since raw materials are cheap, unlimited.

• Atlas' improved catalytic process now turns out a better product in higher yields and at a lower cost than ever before. The process is efficient, needs few critical materials.

▶ **Availability Goes Up**—This year, with a second unit going on stream, the Atlas plant at Atlas Point (near Wilmington, Del.) could turn out close to 75 million pounds of sorbitol annually. This is a big jump from the 22.5 million pounds of 1951—and a 10-fold hike over the 7.5 million pounds of 1950.

This latest expansion, Atlas people say, will go a long way to relieve any polyol shortage that might crop up within the next few years. The importance attached to its role in our arsenal economy is reflected in the 70 percent amortization granted Atlas in its certificate of necessity; average for the chemical industry has been about 55 percent.

What's more, Atlas is ready and willing to hike its sorbitol capacity at any time another serious polyol shortage threatens—or sooner, if sorbitol catches on fast enough among polyol users.

And on one point Atlas is confident: with about 20 billion pounds of sugars available annually, it'll never be caught in a raw material squeeze.

* Most important are glycerine, ethylene glycol, propylene glycol, pentaerythritol, sorbitol, diethylene and triethylene glycols.

† "Availability" here designates an amount which could be brought readily into the economy should an emergency arise.

▶ **Costs Go Down**—Sorbitol has had a downward price trend. Today it sells at the lowest price in its history: 15.5 c. per lb. for the 70 percent aqueous solution in tank cars fob. works.

Most competitive poloyls, in contrast, have gone up in price since Korea: glycerine almost 100 percent; pentaerythritol, propylene glycol and ethylene glycol some 17 percent.

Behind sorbitol's price stability is an efficient process based on relatively cheap and inexhaustible sugars: corn, cane or beet.

Future price of sorbitol will be governed primarily by the price of sugar and, to a lesser degree, by labor costs. Corn sugar—which is competitive with other sugars for many uses and hence has little tie-in with the price of corn itself—isn't likely to rise much except from the pressure of inflation. Corn sugar is currently the preferred raw material.

Petroleum raw materials for most other polyhydric alcohols, on the other hand, show a rising price trend above what might be expected from inflation.

With the possible exception of diethylene glycol, sorbitol now has, in fact, a price edge over other competitive polyols. And it's likely that this differential may gradually widen.

On the basis of new facilities, sorbitol might very well be the lowest cost polyol, including synthetic glycerine, in the U. S. in both capital investment and operating costs. This, of course, doesn't necessarily hold for older plants where the investment has been largely written off.

Atlas' improved process also turns out crystalline d-sorbitol of high purity. Reducing sugars are under 0.10 percent, ash less than 0.02 percent. Iron is down to less than 3 ppm., nickel to less than 5 ppm. This high purity is important for some uses, such as in foods and pharmaceutical products.

▶ **Uses Spread Out**—Sorbitol is one of the most versatile polyhydric alcohols: except for anti-freeze, and possibly hydraulic fluids, it can be used in all the major recognized polyol applications.

But it has its own exclusive uses, too. Right now, for instance, Atlas is its own biggest customer. It uses sorbitol to make a large number of organic esters. Most important are the "Span" series of partial esters of sorbitol anhydrides and the common fatty acids, and the "Tween" series of surface active agents formed by condensing polyoxyethylene chains at the non-esterified hydroxyl positions of the "Span" esters.

Sorbitol is also the prime raw material for the synthesis of vitamin C by

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fermentive oxidation. In 1950, some 3 million pounds of sorbitol presumably went into the production of over 1.3 million pounds of asorbic acid and its salts.

But sorbitol's big opportunity lies in the recognized polyol markets—markets that during 1951 gobbled up close to a billion pounds of glycerine, glycols and other polyalcohols.

One of the biggest of these—and perhaps the most promising—is alkyd resins and resins gums. Here some 130 million pounds of polyols, mostly glycerine and pentaerythritol, were used last year. Sorbitol is gaining as a partial replacement for both these.

As a humectant in tobacco, sorbitol seems to be replacing glycerine, where it has a price edge and technical advantages. The tobacco industry uses close to 45 million pounds of polyol humectants annually.

Sorbitol is also making wide sweeps into other fields, chiefly as a humectant. It's just beginning to cash in on the huge food and candy field, has made solid gains in cosmetics and dentrifices, shows interesting new possibilities in drugs and pharmaceuticals.

The paper field hasn't been fully explored yet. But sorbitol is already being sold in carload lots for cellulose sponges and bottle seals. It is also used in cork compositions, gaskets, adhesives, printers' supplies, textiles and hundreds of other places where humectants are needed.

With such growing uses and diversified markets, what are the prospects for the future? A lot, of course, will depend on which way the U. S. economy goes. But it's a fair assumption that sorbitol's present availability of some 75 million pounds annually might well be doubled within the next five years.

▶**Process That Does It**—This recent rise of sorbitol hinges on the improved high pressure catalytic process developed by Atlas' engineers and chemists.

Atlas first began pilot plant production of sorbitol in the early 1930's. The first commercial unit went into production in 1937. The process then used was the batch-wise electrolytic reduction of corn sugar.

During World War II output was almost tripled, but still never met the demand. Meanwhile, Atlas engineers were developing a catalytic process that was not only cheaper but could reduce corn sugar to sorbitol in a matter of minutes whereas the electrolytic method took days.

In 1947 the company was able to convert completely to the faster catalytic process. Since then Atlas engineers have made constant improve-

ments until now the process is remarkably efficient. This made possible the recent expansion program that quadrupled potential output within the past twelve months.

The present process needs less capital and labor than the earlier electrolytic method. It turns out a better and a cheaper product, requires no critical raw materials and only a trace of nickel catalyst. The equipment requires very little stainless steel.

The process has five main steps: (1) preparing the reaction slurry by dissolving refined sugar in water and mixing with nickel catalyst; (2) continuous catalytic reduction of the sugar to sorbitol with hydrogen in a specially designed high pressure reactor system; (3) filtering off the spent catalyst from the solution and reprocessing it for return to the system; (4) purifying the solution by ion exchange and decolorizing it with activated carbon; (5) concentrating the purified sorbitol solution in a vacuum evaporator and adjusting its concentration by adding demineralized water.

Refined corn sugar is unloaded from hopper cars by a pneumatic conveyor system and sent to huge steel storage tanks. Hydrogen is made from coke by the steam-iron process.

Supported nickel catalyst is made in a series of steps that involve the use of acid, alkali, nickel, carrier and hydrogen.

Heart of the process is the continuous reactor system where the catalytic reduction of sugar to sorbitol takes place. The reactor system consists of several vertical steel tubes connected in series.

The slurry of sugar solution and catalyst is pumped from a surge tank into the reactor system with a variable speed triplex pump at a pressure close to 125 atm. Hydrogen from the low pressure gas holder is compressed and stored at about 175 atm. in a pressure vessel outside the autoclave building. From here it is fed into the system.

Reacted slurry and excess hydrogen discharge continuously from the reactor system into a separator. Unreacted hydrogen is returned to the system. The sorbitol solution is separated from the spent catalyst in a pressure leaf filter. The spent catalyst is processed and reused.

From here on the process is a matter of purifying the sorbitol solution by ion exchange and treatment with Darco activated carbon, then concentrating and adjusting final strength. Most of the product is sold as Sorbo, a 70 percent solution of D-sorbitol.

Prior to demineralization, all equipment is of ordinary steel. Corrosion is negligible. The ion exchange unit is

made of rubber-lined steel. All equipment after this step is of stainless or stainless-clad steel to insure product purity.

Not a Telescope . . .

. . . but a Hortondome roof recently installed at Socony-Vacuum's petroleum refinery in French Morocco. This single 31-ft. dome serves as a "breather" (to cut down vapor losses by evaporation) on five gasoline storage and servicing tanks. It is the 41st Hortondome installation since Chicago Bridge & Iron Co. introduced the design in 1949.

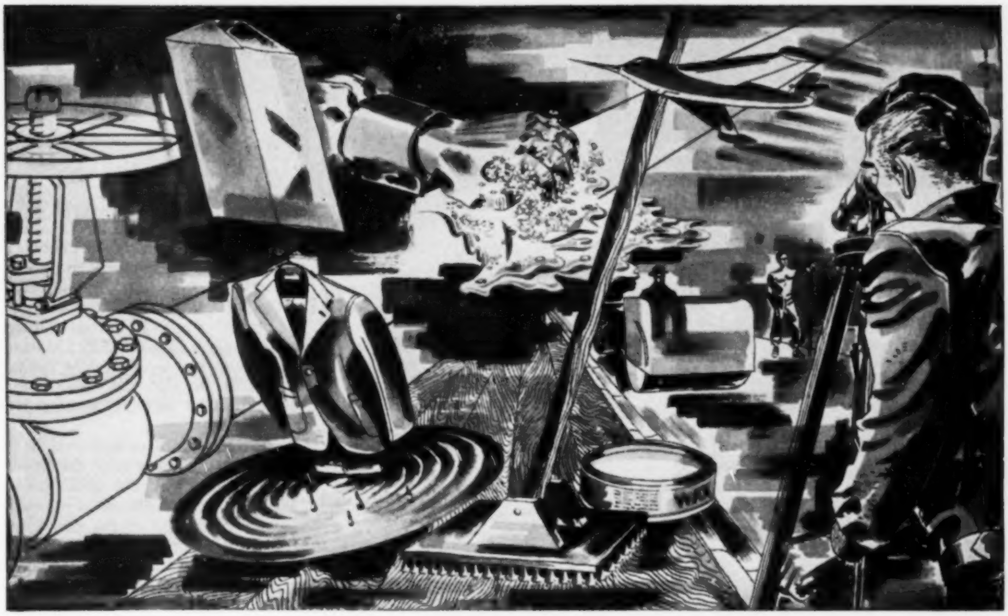
Size Up Coming Trends In Fatty Acid Industry

Surface-active agents not based on animal or vegetable fats have cut into the market for fatty acids, deep enough to hurt. For manufacturers of fatty acids, it is a just cause for worry. So to relieve their fears, they recently met in New York's Waldorf-Astoria to survey the industry's future.

Members of consuming industries were called on for advice and estimates of future demands. They told the manufacturers:

- Products will have to be standardized. A difference in iodine value or in the stearic-palmitic ratio is critical for some products.
- For use in toiletries, the producer of a new fatty acid mixture or derivative who runs clinical tests has his foot inside the sales door.
- For use in paints and resins, the trend is toward performance rather than strictly chemical testing. American Cyanamid, for example, prefers to test the color qualities of an acid by actually making a resin sample and then observing its color.
- As the rubber industry grows, fatty acid consumption should in-

Dissolve your process problems with ROOSEVELT solvents



Every product you see here has one thing in common . . . each uses a Roosevelt aliphatic naphtha at some time during its manufacture or use. In many cases a specific process problem had to be solved . . . sometimes by the selection of a standard Roosevelt solvent . . . sometimes through the use of a special solvent, specially produced to the manufacturers' specifications.

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crease, except for black GR-S. Here, rosin acid soap is proving a better solubilizing agent for zinc oxide.

• Use of fatty acids or fatty acid soaps in lubricating oils and greases is on the decline.

Trend in Chemical Industry To Sale of Stocks and Bonds

At one time in the chemical industry, depreciation reserves and retained earnings supplied capital for current expansion. Not today. Higher taxes, increasing costs and rapid expansion have set a new trend in chemical financing: the sale of stocks and bonds.

Last year 19 of the 39 companies in the portfolio of the Chemical Fund, Inc., raised over $942 million through new security issues. Of this, $665 million was in the form of debt capital; over $276 million was risk capital raised by the sale of common or preferred stock.

Some $121 million was used to retire old issues, and to cover the financing operation. This left $821 million for expansion programs or working capital.

But not all of this reflects immediate expansion plans. The capital in many debt issues need not be taken for a number of years–usually five. Interest rates for keeping the money on hand are low, and such interest is deductible for tax purposes.

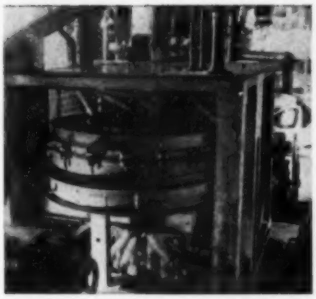
Sulphuric Acid Plant to Use New Recovery Method

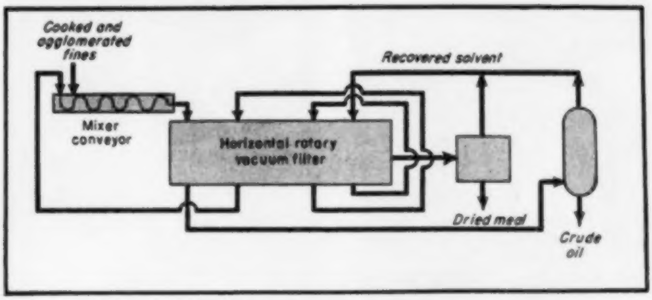
Monsanto Chemical Co. will build a 250-ton sulphuric acid plant at Avon, Calif. Basis of the new plant will be the Monsanto-Ross-Wilde process, a flexible, low-temperature method for recovering acid from refinery sludge.

The process, developed during World War II, recovers a high percentage of acid in refinery sludges in the form of a gas containing SO_2. This gas is much higher in sulphur content than the gas obtained by burning elemental sulphur. Acid produced by treating this gas is water white and no different than new acid produced from elemental sulphur.

Waste sludge and hydrogen sulphide will be piped from the adjacent Tide Water Associated Oil Co. refinery. The plant will be owned jointly by Monsanto and Tide Water.

Most of the sulphuric acid produced will be piped directly to the Tide Water refinery to be used in the processing of aviation gasoline and other products.





Continuous horizontal rotary vacuum filter shown separates miscella almost instantaneously from meal.

Extract More Cottonseed Profits

New filtration-extraction process lowers investment and operating costs. As an added attraction, it can be adapted for use with other oilseeds.

Most cottonseed oil produced in the U. S. is expressed in hydraulic press boxes. Now a simplified direct filtration-extraction process has been developed which promises to make new and substantial inroads.

The process requires no radical or expensive departure from operations now used to prepare seed. It can handle cottonseed of a wide range of moisture content, consumes little solvent.

So far, solvent extraction has been more or less limited to large scale installations processing 200 to 400 tons of seed a day. The new process, according to developers E. A. Gastrock and his associates at Southern Regional Research Laboratory, could extend its use considerably to small plants to which it is particularly suited.

Yields consist of a superior quality crude oil and a meal product having a residual lipids content of 1 percent or under, free gossypol of 0.03 percent or under, and a comparatively high protein solubility.

▶**Less Solvent and Equipment**—Less than 1 lb. of the solvent, commercial hexane, per lb. of cottonseed meats is used. Less solvent hold-up in the entire plant means less equipment volume.

The oil-solvent mixture has an oil content of 25 to 30 percent. It contains only about 0.3 percent fines, coarser than those obtained by direct extraction of raw cottonseed flakes. So only a minimum of clarification using inexpensive equipment is required.

Solvent content of the solvent-damp extracted meal is 30 percent or less. Hence, oil and meal recovery operations should be cheaper than those used for present solvent extraction processing.

▶**No Expensive Departures**—Conventional methods for cleaning, delinting and hulling yield a final meal of 41 percent protein. Existing rolls and cookers prepare the meats for extraction; conditions are modified to comprise moist cooking at low temperature, partial drying, cooling and rerolling. In this way (1) fines are consolidated into larger agglomerates; (2) oil is essentially freed from meal tissue, facilitating rapid separation; (3) free gossypol is reduced to 0.3 percent or less; (4) protein solubility is 30 to 40 percent.

The resulting light brown, grit-like material, together with hexane or oil-solvent mixture from one of the wash stages, continuously feeds into a trough. Simply designed, the trough is 1 ft. in diameter by 12 ft. long containing a paddle-type mixer-conveyor. To achieve thorough solution of oil in the hexane, hold-up time of only 10 to 15 min. is required. Slurry (about 40 percent solids, 30 percent oil in the liquid) goes down a 3-in. diameter inclined conveyor.

▶**Only Simplification**—A 3-ft. diameter continuous, horizontal rotary filter receives a uniform deposit of the slurry. This is the most important step in the process according to SRRL researchers. The bulk of the miscella from the slurry is separated almost instantaneously from the meal. The first filtrate goes on to the oil recovery unit.

During its 1 to 2 min. stay on the revolving filter pan, the meal cake gets three counter-current washes. A rotating scroll discharges the drained meal which has been defatted to less than 1 percent.

The pilot plant filter has processed up to 18 tons of cottonseed per day or 6 tons per day per sq. ft. of filtering area. SRRL has also conducted successful pre-pilot plant and full pilot-plant tests on both soybeans and rice bran. And study on other oilseeds is underway.

Engineering Developments Cut Cost of Plutonium in Half

In spite of substantial boosts in the cost of salaries, wages, materials and supplies since 1946, plutonium makers have cut the unit cost of the metal 50 percent. One reason: new developments, the result of concentrated research, have simplified processing.

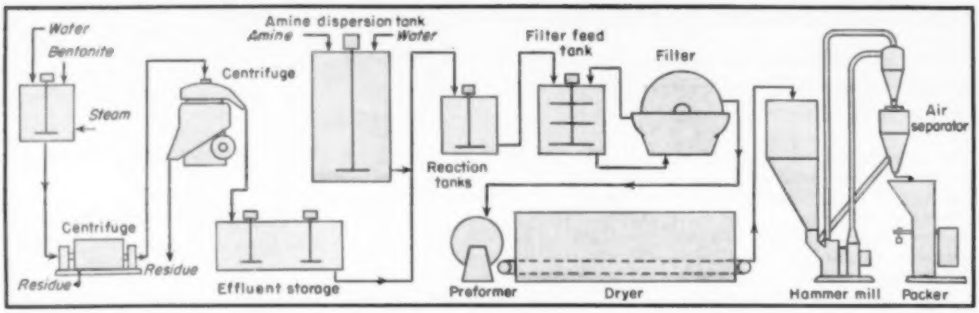
Besides working out the new developments, engineers have solved many practical and less exciting production problems. One of the principal reasons for the big reduction: Although new techniques have simplified operations, they also have quickly outdated existing facilities. Engineers were handed the problem of reconverting, or at worst, salvaging this equipment.

They have had fair success in reconverting. For example, at its Hanford plutonium works at Richland, Wash., General Electric is operating facilities supposedly obsolete in 1949. To replace them today would cost $225 million.

Surprising note: In spite of stepped up production and process changes, safety records at the Hanford works are better than average. Last year GE had five lost-time accidents with 17.4 million exposure man hours—a frequency rate of 0.29 compared with the company's over-all average rate of 3.76.

At Hanford, GE makes plutonium from natural uranium that contains isotope-238 predominantely, and 235 one part in a hundred forty.

After the reaction of bentonite with amine, the product is dewatered, dried, pulverized and the finished Bentone packaged.



Output of Bentones Climbs

These versatile gelling agents, made by reacting bentonite clay with organic amines, are in growing demand by diverse industries.

So fast have the Bentones—a novel class of gelling agents for organic liquid systems—caught on that the Baroid Sales Division of National Lead Co., which introduced them, is currently tripling capacity of its St. Louis semi-works unit. This unit is now operating at capacity.

It's estimated that this expansion will be completed in about two months. National Lead will then be able to meet immediate future demand for these products from the lubricating grease, paint and lacquer, printing ink and other industries.

Meantime, plans for a full-size plant are on the drafting board, although its site and capacity haven't yet been determined.

▶ **What They Are**—The Bentones are the reaction products of organic bases with the clay bentonite or its clay mineral component montmorillonite. The reaction is a cation exchange.

What happens essentially is that sodium bentonite, plus an organic ammonium or onium salt, undergoes an equilibrium reaction to form an organic onium bentonite plus salt. Insolubility of the onium bentonite compound favors the reaction to the right.

Bentone 18, as its name suggests, is octadecyl ammonium bentonite. It will disperse and swell to produce gels in some single organic liquids, but is generally best adapted to gelation of binary systems comprising a large proportion of a non-polar with a small proportion of a polar liquid.

A more versatile material is Bentone 34, which is dioctadecyl ammonium bentonite. It will gel many single organic liquid systems such as aromatic hydrocarbons and various aliphatic liquids such as petroleum oils.

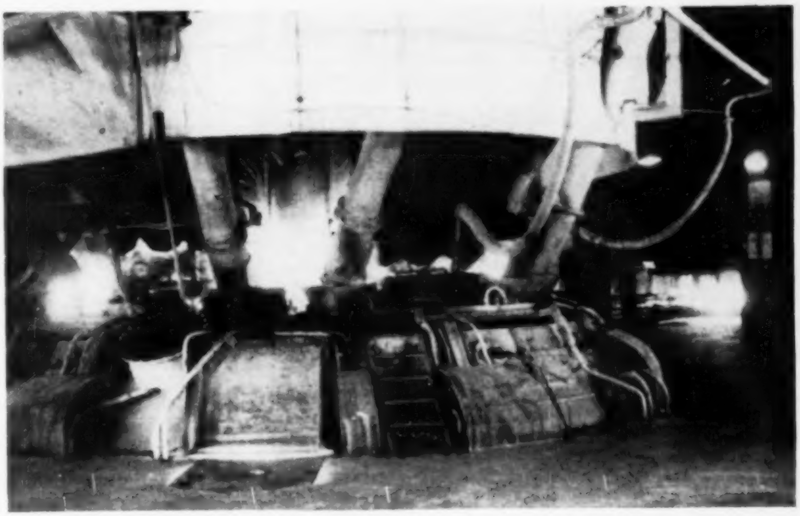
▶ **Research to Pilot Plant**—Building on foundation work laid by E. A. Hauser, researchers at Mellon Institute (under the fellowship of the Baroid Sales Division) prepared a large number of compounds and studied their chemical, physical and rheological properties. After evaluation of manufacturing methods, a pilot plant was built at Mellon. It provided materials for market research, and processing and equipment data were worked out for the design of a commercial plant.

Use research was split up between Mellon Institute and the Brooklyn laboratories of National Lead. Potential uses for the Bentones in lubricating greases and paints were investigated.

Important properties of gelled systems containing Bentones came to light. Among them: complete absence of melting at high temperatures; lack of phase changes at any temperature, including very low ones; resistance to action of water, due to freedom from hydrolysis and its byproducts; and stability of gel structure on standing or under mechanical working.

▶ **Scale-Up**—Going from pilot plant to semi-works with the Bentone process called for a switch from a batch process to a modified continuous process, and for a scale-up of 20 to 1.

This switch to a continuous process, while fortunately desirable, was virtually mandatory in the face of the low concentrations employed, and conversely, the huge volumes of materials handled per pound of final product.



In the centrifugation operation, for example, the types of commercially available centrifuges suitable for large quantities of residue dictated unquestionably that this operation be continuous. Similarly, a filter cake solids content of approximately 13 percent, coupled with the specification that the cake be washed salt-free, indicated a continuous filter and dryer.

By following these operations with continuous milling, the major steps of the process are now continuous, leaving only clay dispersion, amine dispersion and reaction as batch operations.

Thus, when the eventual task of expanding to a completely continuous process materializes, full-scale data will already be on hand for the critical phases of the process.

► **Production**—The Bentone manufacturing sequence begins with the dispersion of bentonite clay in water, using turbine agitators. The dispersion is heated and a deflocculating agent added to improve centrifugation.

This centrifuging operation completely removes the non-clay components by the use of two continuous centrifuges in series. First the coarse fraction is removed, followed by a "polishing" separation in a high-speed automatic centrifuge that develops a centrifugal force of 6,400 times gravity. The centrifuge effluent is collected in an oversize storage tank holding about three times the daily requirement, thus buffering minor daily variations and insuring a uniform reactant.

The second reactant, the amine, is received in 55-gal. drums, heated until molten, then measured and dispersed in hot water. Precise control analysis of the two reactants is essential at this stage to maintain the optimum ratio of amine to bentonite in the reaction mixture.

Amine dispersion is metered into the centrifuged bentonite dispersion to form the reaction mixture. The reaction proceeds as rapidly as the turbine agitators can uniformly distribute the amine, yielding the Bentone as a flocculated precipitate.

Bentone-laden slurry is pumped to a rotary vacuum filter, where the soluble salts are washed out and preliminary dewatering takes place. Filter cake is then fed to a grooved steam-heated rotating drum, which discharges partially dried rod-shaped preforms onto a moving screen. The screen passes through a steam-heated dryer in which heated air is forced through the bed of preformed wet product.

When dry, the Bentone is pulverized in a hammer mill and packaged in 50-lb. bags.

► **Growing Markets**—The Bentones are extremely versatile, with applications in many industries.

Bentone 34, for example, is widely used in the lubrication industry to thicken oil to a grease, replacing soaps for that purpose. The resulting greases won't melt at any temperature, and are extremely stable to working since Bentone 34 is inert and there are no changes of phase. Other points of superiority over conventional greases: complete water resistance, better metal adhesion, no leakage at high temperatures and improved properties at low temperatures.

Initial success of Bentone greases came in high-temperature applications, but recently greater emphasis is being put on their multi-purpose character. It's expected that as use of these materials develop, they will command a major part of the grease market.

In paints, lacquers and stains, the Bentones inhibit settling and separation of pigments and fillers, and make these coatings easier to apply. Because they are inert, their behavior over long-time storage is predictable, unlike that of soap-type thickeners.

In printing inks, Bentones make possible greater viscosity control than ever before achieved. This means higher speed printing operations without throw-off. What's more, body is maintained even though the ink heats up during printing. At present, Bentones are used primarily in heat-set type inks, but recent work indicates they are equally suitable for rotogravure and even newspaper inks. Economically, the improvements imparted by the Bentones seem to more than justify the slight cost increase due to their use.

Tensile strength of waxes can be greatly increased by adding very small amounts of Bentones. This works just as well for paraffinic waxes as for the vegetable and ester waxes. This greater strength means equivalent results with less wax or better results with the same amount of wax. Bentones also reduce the moisture permeability of wax film and improve fold endurance.

Where summer heat causes softening and deterioration of asphalts and tars, the Bentones greatly reduce this effect of temperature increase.

In adhesives, particularly cut-back asphalt adhesives and certain rubber adhesives, Bentones impart bond strength and improve moisture resistance. Addition of Bentones also makes these adhesives easier to apply.

Use of Bentones in putties and allied compounds stops separation of oil and settling of fillers, giving better stability and working properties.

For casting resins, plastisols, organisols and other resinous compounds,

Bentones make possible applications otherwise difficult or even impossible. For instance, a plastisol with the Bentones can be made to a consistency suitable for extrusion or for slush molding or for dipping, with improved handling characteristics.

▶ **Prospects**—All in all, the market potential of the Bentones is big and growing, with applications in a diversity of industries. In fact, demand grew so steadily during the past two years that the decision was reached to triple capacity of the St. Louis plant and start design work on an even larger commercial plant.

Safety Makes Continuous Nitration Process Popular

According to nitration experts, the batch and the continuous processes give the same production efficiency and product requirements. They could on this basis compete with each other. But, in the Biazzi process for continuous nitration, explosion potential is held to a minimum—a safety factor and a bonus that lately has drawn much attention to the 17-yr.-old process.

Within the next two months, Canadian Industries Ltd., will put the process on stream at its Calgary, Alberta, plant.

Du Pont has worked on the Biazzi process for several years, and now will set it up in a new explosives plant at Martinsburg, W. Va. Two more installations, both behind the security curtain, point to the forming trend. At least in North America—it has been used extensively in Europe for some time.

Selling point is its added safety. In batch nitration 7,000 lb of nitroglycerine charge a batch reactor; in the Biazzi, 100 lb. During nitration, automatic controls shut off the feed if the power fails or the reactor temperature reaches the danger point.

The nitrator, a cylindrical stainless steel vessel with a helical cooling coil and internal agitator, takes feed directly from the storage tanks. Nitrated product and spent acid are continuously withdrawn from the side of the vessel.

Squat, stainless steel tanks, which carry out separation, take feed through the side at the layer of emulsion, between the separated layers of acid and product. Presumably, rotation agglomerates the tiny droplets in the emulsion layer.

Similar tanks, connected in series, serve for the washing operation. High-speed mechanical agitators (in the batch process, it's air) do the mixing.

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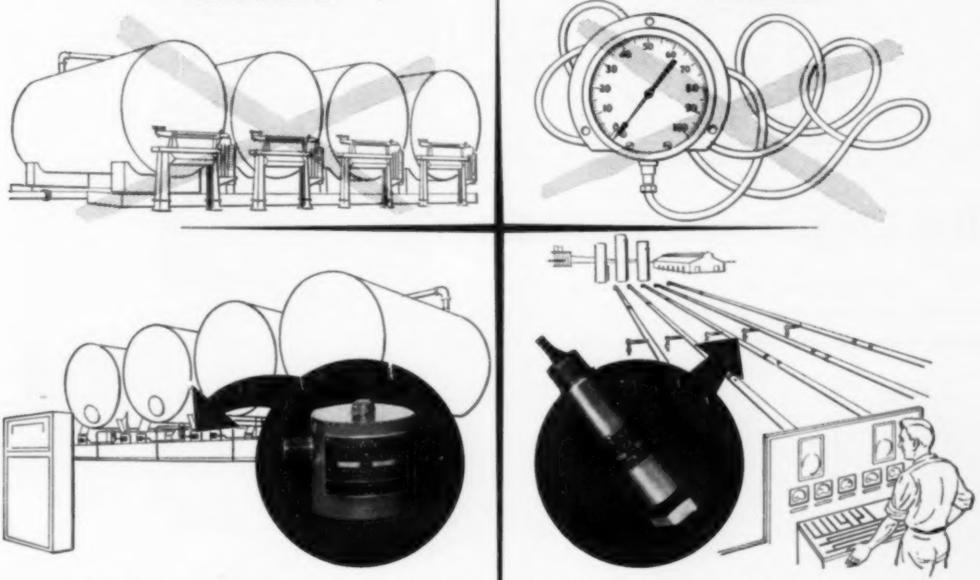

Baldwin SR-4 Load Cells bring new simplicity, sensitivity and reliability to measuring and batching liquids by weight. Cells may be located under existing supports, require small headroom, and record without appreciable movement of the sensing element. As units are completely sealed, cleaning is simplified, and corrosion and deposits no problem.

The indicating, recording or control instrument may be located at any convenient point, and used to report the weight of material in any number of tanks or hoppers. Elimination of pitting and multiple parts cut costs.

Baldwin SR-4 Pressure Cells provide an accurate, economical means of measuring, controlling or monitoring fluids and gases. Cells may be placed at any desired location, and through electrical connections will "report-in" continuously to a remote central point. Another important application is in research, as the cells provide an unusually accurate means of measuring ultra-high pressures, surges, and explosion waves. Hysteresis and inertia effects are virtually abolished.

HEART of all SR-4 measuring devices is an SR-4 strain gage which consists of a postage-stamp-sized grid of very fine wire.

This grid is cemented to the inside of the SR-4 device or, in strain analysis work and other types of measuring, directly to the piece under test. Changes in the load applied to the testing device (or test piece) change the electrical resistance of the wires in the grid.

By using a simple potentiometer or a Baldwin SR-4 Wheatstone Bridge Control Box, minute changes in pressure, weight, torque, etc., can be determined easily, inexpensively and with unusual accuracy.

If you have any measurement problem, it will pay you to investigate the unusual advantages of SR-4 strain gages and measuring devices.

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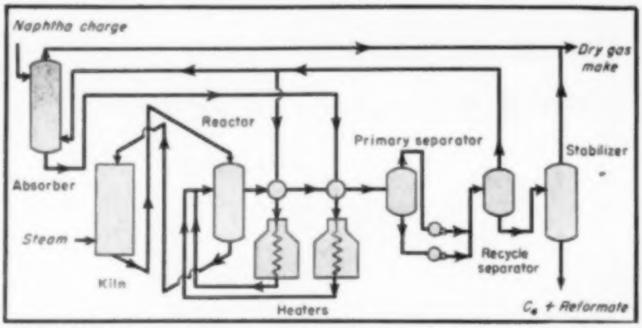

NEW reforming process benefits from older Thermofor Catalytic Cracking design.

Big Commercial Plans for TCR

Based on an alumina-chromia catalyst and 50-80 percent lower pressures, Thermofor catalytic reforming will be going into six new refineries of Sohio and Socony-Vacuum.

Add TCR to your alphabet of catalytic reforming processes. The Thermofor catalytic reforming units, low pressure cousins of Socony-Vacuum's Thermofor catalytic cracking (TCC) units, will be installed at three refineries* (General Petroleum's Torrance, Calif., refinery, Socony-Vacuum's plant at Augusta, Kan., and the Beaumont, Tex., refinery of Magnolia Petroleum). All three are part of a $27 million construction program of the company of the flying red horse. For good measure, the program includes a catalyst manufacturing plant for Paulsboro, N. J.

Heart of the process developed by Standard Oil Co. (Ohio)* will be a cogelled chromia-alumina catalyst in bead form.

▶ **Lower Pressure TCC**—Here's how it works. Similar to the TCC system, gravity carries the catalyst, in moving bed form, continuously through a reactor and a separate regenerating kiln. A conveying system takes regenerated catalyst back to the reactor.

Big advantage of TCR is its ability to operate between 100-200 psig., or put another way, at 50-80 percent lower pressures than competing processes. Besides simplifying catalyst regeneration, that means lower first costs for a new installation.

---

* The TCR process was developed by Standard Oil Co. (Ohio) under the direction of E. C. Hughes, chemical research chief of the company. About two years ago, Sohio sold its 30 patents on the process to Socony-Vacuum on a cash and royalty basis. Sohio retains rights to use the process in its refineries without royalty, is currently planning TCR installations at Cleveland, Lima and Toledo.

As in conventional catalytic reforming operations, the reactor gets continuously recycled hydrogen-rich gas. Conversion reactions included are isomerization, cyclization, dehydrogenation, desulphurization and hydrocracking to produce high-octane reformate rich in aromatics.

▶ **Coking No Problem**—Compared to catalytic cracking, only a small amount of coke is deposited on the TCR catalyst. For that reason catalyst circulation in the process is relatively small—less than 10 percent of the amount circulated in the modern air-lift TCC units.

Because it provides continuous regeneration for the catalyst, TCR is widely flexible in the boiling range of the charging stocks it can handle, so prefractionation or feed-preparation units will not be needed.

High severity of operation is no problem, either. With slight coke deposits, simpler catalyst regeneration raises the allowable limits of severity necessary to turn out higher-octane reformate.

▶ **Sulphur Bonus**—Easily, where stocks of higher sulphur content are processed, TCR eliminates most of the sulphur as H_2S. In test runs made at Socony's 50 bbl.-per-day pilot plant at Paulsboro, N. J., a California straight-run plus coker-gasoline feed containing 0.56 percent sulphur gave a reformate with 0.036 weight percent sulphur. Since the unit planned for Torrance, Calif., will run high in sulphur, plans are to recover the H_2S which will be converted to elemental sulphur at a nearby plant of Hancock Chemical Co.

The three catalytic reformers will have a total rated capacity of 37,000 bbl. per day of naphtha charge stocks. The cat reformers, two of which will be among the largest in existence, will produce aviation blending stocks mostly. No separation of benzene, toluene or xylenes is planned since the avgas will take all of the light reformate.

Use Cobalt Isotope For Steel Inspection

This ampoule of radioactive cobalt wire, one of the first industrial products to come out of Oak Ridge, is used for spotting internal defects in cast steel.

The cobalt isotope sends out powerful beta and gamma rays that penetrate up to 6 in. of steel. When used with a photographic film, the rays will produce a picture of any defects in the steel.

Apparatus consists of the radioactive wire mounted in a circular holder and elevated over the casting by means of a cross-arm attached to a laboratory stand. The height of the ampoule from the steel depends on the thickness of the steel. Exposures range from 0.5 to 6 hr.

Cost of this isotope, held by metallurgist Harold Kurtz of the Empire Steel Castings, Inc., was $450. Comparable amount of radium weighing 525 milligrams would cost about $10,000. The unit has a half-life of 5.3 years, but can be used up to ten years, with diminished efficiency after the half-life period.

The isotope was purchased from a civilian chemical firm with the permission of the Atomic Energy Commission. No security regulations were involved.

fluor's modern research facilities

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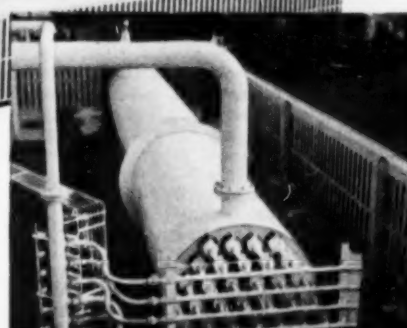
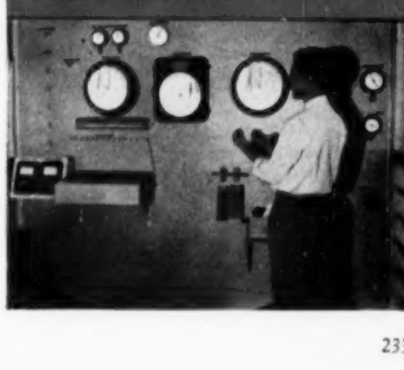
At Fluor, the proof of the design is in the testing. *Before* new Cooling Tower developments are incorporated into standard design, they are subjected to rigorous tests in this modern, commercial-size tower testing laboratory. Here, design and performance efficiency of every new development is determined through complete ranges of actual heat transfer conditions. Realistic rating data is established under conditions *paralleling* those of plant and process operations.

Fluor Cooling Tower Testing Facilities. This commercial-size installation consists of a pump house, instrument house, 20,000,000 BTU/H boiler, test basin, and a 40' high test tower.



This specially designed [illegible] Burner-Type Boiler provides varying heat loads to the test tower. Fired by 37 hydraulically-controlled burners operating on either natural gas or propane, the boiler delivers a maximum heat load of 20,000,000 BTU/H.

Testing is controlled from this single panel. Instrumentation includes measurement and recording of heat loads and water flow rates, air temperatures, hot and cold water temperatures, air static readings and all other pertinent data, under a variety of conditions.



What this means to you . . .

The motivating power behind Fluor's continuous research and development program is to *always* provide the most efficient cooling tower available. This fact, combined with Fluor's 30 years of active experience in designing major cooling tower installations for the petroleum, chemical, and power industries, means many things to the man seeking a factual tower recommendation to meet his exact cooling requirements.

A Fluor Cooling Tower recommendation means that all variables are included and compensated for. It means that all component parts, as well as all design theory, have been tested and evaluated under actual operating conditions. And, it means that a Fluor-designed cooling tower will perform at *rated* heat transfer efficiency under the conditions of installed operation. ***You can be sure with Fluor!***

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TREATER cuts gel into small pieces and promotes shrinkage.

DOUBLE-DRUM press continuously dejuices shrunken gel.

Novel Process Treats Wastes

Troublesome fruit wastes now made into salable products. Chemical process hinges on ingenious treater and simple drum press. First commercial unit to operate soon.

Pacific Biochemical Co., a new firm, will soon start up its plant near San Jose, Calif., to turn fruit cannery wastes into molasses and and dried pulp for cattle feed.

The San Jose unit will treat over 150 tons of pear and peach wastes per 24-hr day. It will be the first commercial plant to use the new continuous chemical treating process developed by the Department of Agriculture's Western Regional Research Laboratory* at Albany, Calif.

WRRL's process has been demonstrated in large pilot plant equipment over the past few years. Pacific Biochemical recently bought the facilities for $200,000 and is converting them into a commercial unit at an additional cost of close to $100,000.

▶ Process Is Ingenious—The new process that Pacific Biochemical will use at its San Jose plant hinges on six operations:

- Grinding the wastes (mostly peels, trimmings and cores) to uniform consistency in a conventional rigid-hammer disintegrator;
- Treating the slurry with lime to raise its pH to about 8.5-9;
- Conditioning the gelled waste continuously in a horizontal treater equipped with a multiple-blade agitator that acts as an interrupted-flight conveyor (*see cut*);
- Dejuicing the conditioned waste in a continuous, double-drum press (*see cut*);
- Evaporating the clear juice in a multiple-effect vacuum evaporator to molasses of about 60 percent sugar and 70 percent total solids;
- Drying the wet press cake to about 5 percent moisture in a direct-fired rotary unit.

Success of the process lies in the treating-conditioning and dejuicing operations, point out R. P. Graham and W. D. Ramage of WRRL's staff at Albany.

The continuous treater has two sections. Lime treatment in the first promotes enzymatic de-esterification of the pectin and formation of calcium pectate gel. The treated slurry then flows into a horizontal trough fitted with a slow-moving agitator with its blades arranged to form an interrupted-flight conveyor.

Here the blades cut the waste—now gelled—into small pieces with little crushing action. These gel particles shrink and harden, releasing clear juice. The waste is kept in this first part of the treater for about 10 min. during which there is de-esterification and reaction of pectin with lime, reduction of gel to granules and shrinkage of the granules with release of juice.

In the second part of the treater the gel granules are heated to 150 deg. F. by steam injected through ports in the bottom of the trough. Here they continue to contract and release more juice.

From the treater, the juice goes to a continuous double-drum press. This unit is novel in design, simple to build and efficient in operation. It was developed by WRRL engineers after they found out that pear wastes cannot be pressed satisfactorily in the conventional types of continuous presses. The drums are 4 ft. long and 4 ft. in diameter.

This drum press has a domed chamber where the juice is kept at 2-5 psi. for 2-3 min. to build up a filter cake about 0.5 in. thick on the portion of the drums within the dome. The two cakes are merged and pressed between the drums at about 75 psi.

Press cake drops into a conveyor and goes to the continuous dryer; juice is centrifuged and then evaporated into stock-feed molasses.

▶ Other Uses May Come—WRRL's new-design press may very well find other uses among food processing and waste treating plants. Because of its simplicity, it can easily be built on the job.

Several processing firms are already showing keen interest in the process and equipment. The double-drum press, for instance, would probably work well for treating tomatoes, apples and other fruits; it has already been demonstrated on pears and peaches. Most vegetables, however, would probably require pre-grinding and partial cooking to break up their cell structure.

If these uses should develop, the new waste treating technique might well become a boon to food processors in other parts of the country.

In the Santa Clara area of California alone, pear canneries have a problem in disposing of close to 50,-

* Cooperating with WRRL in developing the process and operating the pilot plant unit near San Jose were the Canners League of California and other industry groups.

1 Low-temperature drying with agitation

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3 Rapidly and economically in

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Stainless Clad Agitator with center heating tube and arms being inserted in a 6' dia. x 36' long Vacuum Rotary Dryer.

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000 tons of waste during each 2-month processing season. The usual practice is to dispose of it by land dumping. But this method has obvious disadvantages.

But now the disposal problem will be solved for the nine pear and peach canneries surrounding Pacific Biochemical's plant; the WRRL-Canners League process will convert their wastes into profit-making cattle feed molasses and pomace.

Loading Atomic Reactor

Operator at Oak Ridge National Laboratory pokes a slug of aluminum-jacketed uranium into a graphite reactor. The air-cooled reactor, a 24-ft. cube built of graphite blocks, is punctured with 1248 of these parallel fuel channels. Operator stands behind a 7-ft. concrete shield, a 3-ft. air space and a 24-ft. moderator. This 3,800-kw. pile first went into operation on Nov. 4, 1942. It then served as a pilot plant for large-scale plutonium production reactors at Hanford, Wash.

CONVENTION CALENDAR

American Institute of Chemical Engineers, process equipment and market research symposia, Biltmore Hotel, Atlanta, March 16-19.

American Chemical Society, national meeting, Buffalo, N. Y., March 23-27.

National Agricultural Chemists Association, spring meeting, Fairmont Hotel, San Francisco, April 7-9.

Association of Consulting Chemists & Chemical Engineers, general symposium, Belmont Plaza Hotel, New York, April 22.

American Oil Chemists Society, spring meeting, Shamrock Hotel, Houston, April 28-30.

American Drug Manufacturers Association, annual meeting, Homestead Hotel, Hot Springs, Va., April 28-May 1.

Ozone Kills Phenols in Waste *

New data now show that ozone is one of the most effective agents for oxidizing phenols in industrial wastes. And it turns out to be far cheaper than everyone thought.

These findings, recently reported for the first time, come as a surprise to most people. Ozone had always been looked upon [illegible]

The new data on chemical oxidation of phenol wastes came from a cooperative study under the direction of the Ohio River Valley Water Sanitation Commission, with Sanitary En- [illegible]

If the presence of phenolic compounds in industrial wastes is a problem to you and your community, low-cost, efficient Welsbach Ozone can be the solution to that problem . . . as proved by the investigations directed by the Ohio River Valley Water Sanitation Commission.

In addition to its low cost, Welsbach Ozone offers dependable, automatic chemical oxidation which requires no full time supervision or labor. With the oxidant being generated at the point of use, there are nc procurement, storage or handling problems. And . . . operating costs are constant and predictable—a most important advantage with chemical costs going up and up, every day.

The record—as shown by the findings of the Commission—proves that Welsbach Ozone should be the oxidant of choice in solving your phenol problem. Welsbach's "know-how" . . . based on years of pioneering in continuing ozone research . . . is at your service. Write or phone for further information.

* *Ozone Kills Phenols in Waste, Chemical Engineering, Vol. 58, No. 9, September, 1951. (Complete reprints of this article are available.)*

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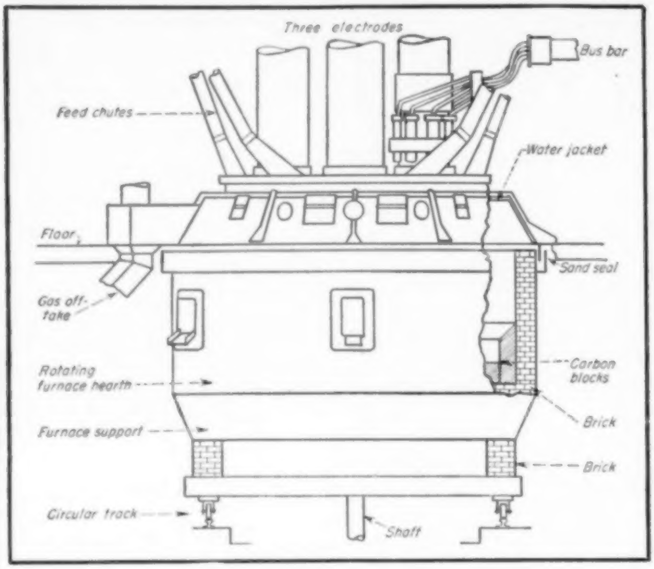

New Covered Furnaces Rotate

Big 24,000-kw. carbide furnaces at Calvert City will rotate. This keeps charge porous and eliminates stoking. Linings will last longer too.

When it comes to designing electric furnaces, U.S. engineers have plenty to learn from the Norwegians. It was the Norwegians who pioneered design of covered rotating furnaces, and it was to the Norwegians that U.S. engineers turned when they wanted to build such furnaces here.

▶ **TVA's Furnace**—First rotating furnace in the U. S. for the production of elemental phosphorus is that of the Tennessee Valley Authority at Wilson Dam, Ala. The 7,500-kw. unit is now in operation. Molten lead provides a gastight seal between the rotating crucible and the stationary roof.

Because of the great weights involved, the rotating arrangement had to be carefully engineered. Therefore, TVA engineers drew heavily on the experience of the Norwegians. In fact, although they incorporated many modifications of their own, their furnace is based on the rotating hearth design of Elektrokemisk A.S., a Norwegian company with headquarters in Oslo.

▶ **Trend to Rotation**—More rotating furnaces will soon be operating in the U.S. At least two major concerns have decided to switch to rotating furnaces.

One of these is National Carbide Co., a division of Air Reduction Co., Inc. Two covered rotating furnaces, designed by Elektrokemisk, are now being built near Calvert City, Ky., where National Carbide is putting up a new $10 million plant.

These furnaces, each operating on 24,000 kw., will be the first of their kind in the U.S. for production of calcium carbide. Built of steel and lined with firebrick and carbon, they will be about 30 ft. in diameter and 20 ft. high. They will thus equal in size the biggest carbide furnaces in the world today.

Completion of the first furnace at Calvert City is expected by January 1953; the second should be ready for operation by March of that year. Initial rated capacity of National Carbide's new plant will be 142,500 tons of calcium carbide a year, and more furnaces can be added to the line.

▶ **Carbide Production**—In these furnaces, molten carbide will be produced by reaction of lime and coke at upwards of 4,000 deg. F. After tapping, the product will be cooled and crushed for shipment. Later, when the Calvert City area becomes a hub for manufacture of acetylene derivatives, National Carbide will generate acetylene from the calcium carbide and pipe it to neighboring plants.

The furnaces at Calvert City will be equipped with Söderberg continuous self-baking electrodes. The electrodes will conduct power at low voltage and high amperage into the furnaces to generate the enormous heat required. Continuous raw material feed and product tapping methods will be used.

▶ **Norwegian Genesis**—The rotating furnace was developed in Norway from the original idea of Tönnes Ellefsen. The first installation, for ferrosilicon production, began operating in 1937 in Norway.

World War II temporarily halted the marketing of this type furnace abroad by the Norwegians, but since 1945 units have been designed for many European countries for the production of ferroalloys. In Norway and Sweden alone, eight rotating furnaces are installed or being built.

▶ **Advantages**—In the rotating furnace, three vertical electrodes, arranged in a triangle, are suspended into the furnace pot, which rotates or oscillates. It takes from 50 to 100 hr. per rotation. This motion counteracts crater formation and helps keep the charge porous. Thus gas, which forms mainly around the lower end of the electrodes, escapes more easily. A sand seal insures gas tightness between the stationary furnace cover and the rotating hearth.

The lining of a rotating furnace will wear more uniformly than that of a stationary furnace. Another advantage is that the contents of the pot can be emptied during one or two rotations, which is particularly valuable when changing from one product to another or when cleaning out the furnace for other reasons.

If the furnace bottom tends to build up, rotation will distribute the deposits over the furnace hearth and the length of the smelting campaign between clean-outs can be increased.

▶ **Covered Furnaces**—Stoking the charge in a covered furnace is a difficult job. For many products, covered stationary furnaces must therefore be operated only with charges of carefully screened raw materials of top quality to avoid hangings and eruptions. But since rotation makes the charge porous, and thus minimizes the necessity of stoking, it is particularly advantageous for covered furnaces.

The first covered rotating furnace was put into operation at the Stockvik plant of Stockholms Superfosfat

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Stockvik furnace turns out carbide.

Fabriks A.B. in Sweden in March 1950. This is a 15,000-kw. furnace for production of calcium carbide, with roof and charging system of Elektrokemisk design.

This furnace has been in continuous operation since the start, with outstanding results. It has digested fine-grained materials so successfully that screening of raw materials has proved unnecessary. A charge containing more than 15 percent of fines −4 mm. (approximately 10 percent −1 mm.) and caused no operating troubles.

There is only one furnace attendant on the instrument platform, and since the operation is more or less automatic, he has little to do. The furnace gas contains more than 90 percent CO. Tapping is carried out in conventional pans.

Experience gained from the Swedish installation went into the design of the covered furnaces for National Carbide. Other covered rotating furnaces are now under construction in Europe for the production of calcium carbide and ferromanganese. And TVA has pioneered the use of the rotating furnace for the production of phosphorus.

▶ **Söderberg Electrodes**—The Söderberg electrode system has been used in practically all European carbide furnaces and larger ferroalloy furnaces for years. All the European rotating furnaces are equipped with these continuous self-baking electrodes and the National Carbide installation will have them too. However, any kind of electrodes can be used. The TVA furnace, for instance, operates at present with graphite electrodes.

So far, Söderberg electrodes have not been used extensively in the U.S. for smelting furnaces. But they have been widely adopted by the aluminum industry. Most of the new U. S. aluminum plants will use Söderberg electrodes.

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Classical Thermo Gets a Jolt

New ideas, presented now for the first time, threaten to topple many of the accepted concepts in thermodynamics —including entropy. The field will soon be rife with debate.

Thermodynamic theory will soon hit the sawdust trail and get converted—that is if the voice-in-the-wilderness of Neil P. Bailey, head mechanical engineering professor at Rensselaer Poly, is heard.

What's needed in classical thermo, says Bailey, is not reformation but purification. And he nails his theses to the door in this issue of *Chemical Engineering* (see p. 150).

▶ Bailey Takes His Stand—Bailey's well-taken stand is that the more you learn about natural phenomena the easier and simpler become the underlying concepts that explain them. But advances in the past 50 years in thermodynamics—as well as aerodynamics and hydraulics—have tended to confound, rather than simplify, the governing theories.

These discrepancies between theory and practice can no longer be blamed on faulty measuring techniques, says Bailey. As the precision of measurements increases, the discrepancies become more apparent.

▶ High-Velocity Fluid Flow—Practical engineering approach to the design of nozzles, pumps, compressors, ejectors, aircraft, and other devices involving flow of fluids has been on a cut-and-try basis. This is because the accepted theories didn't explain things like discontinuities and instability. But a lot of time and money which have gone into developing the rule-of-thumb approach might have been saved by application of the new theory.

Take, for example, the design of a simple differential pressure flowmeter. The factors which make it possible to predict meter calibration have been developed into a rigid discipline. You can accurately define the various dimensions and ratios which give a certain discharge coefficient. But even with the same orifice or nozzle, if you change its location in the line you will change its discharge coefficient.

The new theory accounts for these changes and can actually predict them. "It just didn't make sense," says Prof. Bailey, "to think that the frictional resistance of the nozzle itself could change just because it was in a different position."

▶ What About Chemical Engineers?—What will the new concepts mean to chemical engineers? Directly and immediately, they won't affect chemical engineering practice much—if at all.

Chemical thermodynamics, involving reaction equilibria and heat balances, will continue unchanged, at least for the present.

Bailey does predict, however, that as his new ideas become better understood, they may make useless such intangible concepts as entropy. And indirectly, they'll rationalize the design of equipment which the chemical engineer uses, such as pumps and compressors. One problem in pumping—cavitation—is nicely explained by Bailey's theory.

▶ Some Will Benefit—The groups that'll benefit most—and will probably be most willing to accept the new concepts—are the designers of high-speed aircraft, rockets and guided missiles.

The group that'll probably argue the longest, pro and con, are the power plant engineers.

If Bailey is right, designers of modern turbines have been cheated out of several percent of efficiency, erroneously being credited to the boiler designer.

Bailey has been interested in this problem since his student days in the 1920's. As a research engineer with General Electric during World War II, he was brought face to face with industry's need for a better theory to explain the observed discrepancies at high flow velocities.

Leaving GE to return to teaching, he has carried out experimental work at RPI which closely checks his new theoretical concepts.

▶ New Data to Come—At a meeting scheduled for early next month at Troy, Bailey will present a more complete picture than is published here, including laboratory demonstrations.

Shortly thereafter he will issue a book on the subject, now in press by the McGraw-Hill Book Co. Revised tables of thermodynamic properties of gases and vapors are now being prepared and will follow the book.

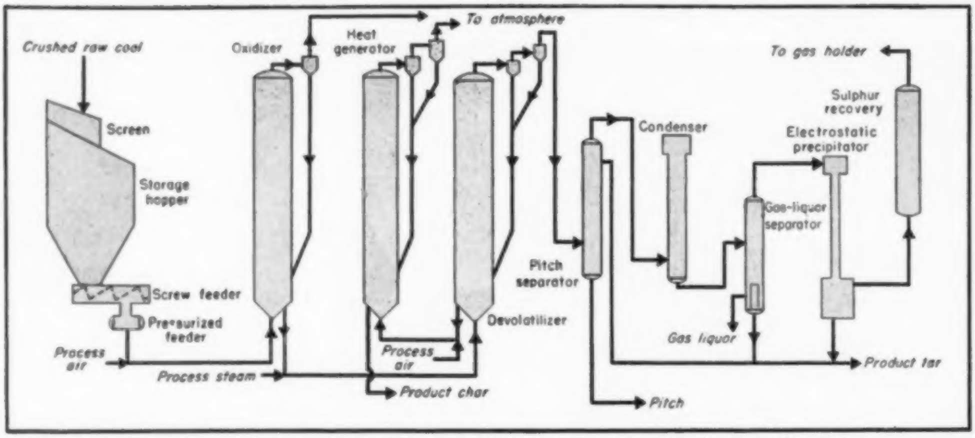
"Thermodynamics," sums up Prof. Bailey, "can be thought of simply as a system of keeping books. The new theory is merely an improved method of accounting."

Rubber Drums Continue To Replace Glass Carboys

Because they are unbreakable, more compact, easy to handle and simple to maintain, rubber drums are gradually replacing the glass carboys.

Recent sign is the latest ICC regulation, Spec. 43A, on all-butyl rubber drums. Formerly, the butyl drum was approved for hydrofluoric acid (up to 60 percent), glycerine, hydrobromic acid and ethylene glycol. Now added to the list is 70 percent phosphorous acid ethyl, N-octyl, isopropyl, N-propyl and N-butyl acid phosphates.

Tests are underway for 45 percent fluoboric acid, 26 deg. Be. ammonium hydroxide, acetic acid (56 percent and glacial), ethyl iodide, benzoic acid solution and 60 percent ammonium thiosulphate.



Using anything from lignite to anthracite, process may be a natural for chemical plants concerned mainly with Btu's.

Coal May Yield Bigger Bonuses

Flexible fluidization process promises more char, tar, gas and sulphur, less smoke. Industries, eyeing large-scale use, back pilot plant.

Coal and coal-using industries are keeping a close watch on a new pilot plant starting up this month. The new char process is said to up the heating values of coals as well as recover valuable byproducts.

Dr. Alamjit D. Singh, president of Singh Co., Chicago, developed the process.* The Illinois Coal Products Commission is financing the \$250,000 pilot plant located just outside of Chicago. Interested chemical, coal and power companies have also loaned materials and equipment to help the venture.

The process uses anything from lignite to anthracite. And Singh gives assurance that it is flexible in operation as well. He places typical yields from a ton of bituminous coal as 1,320 lb. char, 15 gal. tar, 8,200 cu. ft. (580 Btu.) gas and 35 lb. of solid sulphur.

At high temperature operation the Singh process produces large amounts of gas at the expense of tar. This may make it a natural for combined gas-electric utility systems as well as chemical plants concerned mainly with Btu's. Low temperature operation produces less gas, but a good yield of tar for which several markets are developing.

If the pilot plant work pans out, two key features of the process hold particular promise: (1) a low-temperature pre-oxidation destroys resinous compounds, prevents troublesome agglomeration; (2) recycling 25-75 percent of the devolatilized char in intimate contact with incoming coal gives excellent heat transfer (4-6 times conventional coking rates).

▶ Versatile Char—The char product can be burned directly in standard industrial fireboxes. It could also be briquetted for home use, converted to coke for blast furnace use, or used as raw material for production of synthesis gas.

The hollow char spheres are friable, less abrasive to handling and pulverizing equipment, will require less power to pulverize. Heat value of the char (12,180 Btu.) is higher than the raw coal, 11,460 Btu.); ash increases only about 2 percent. Lower hydrogen content of the char also means a 4-6 percent heat economy by reducing stack loss of heat through water vaporization.

Recovered tar oils can be processed for a number of uses. Cracking yields about 39 gal. of heavy fuel or diesel oil, 3 gal. of light oils and naphthas for gasoline blending use.

As feedstock, oils could be converted to benezene, toluene, xylene; or to other organic chemicals by chlorination and hydrolysis. Tar acids, about 6-9 percent of the tar, could be extracted for use in making resins.

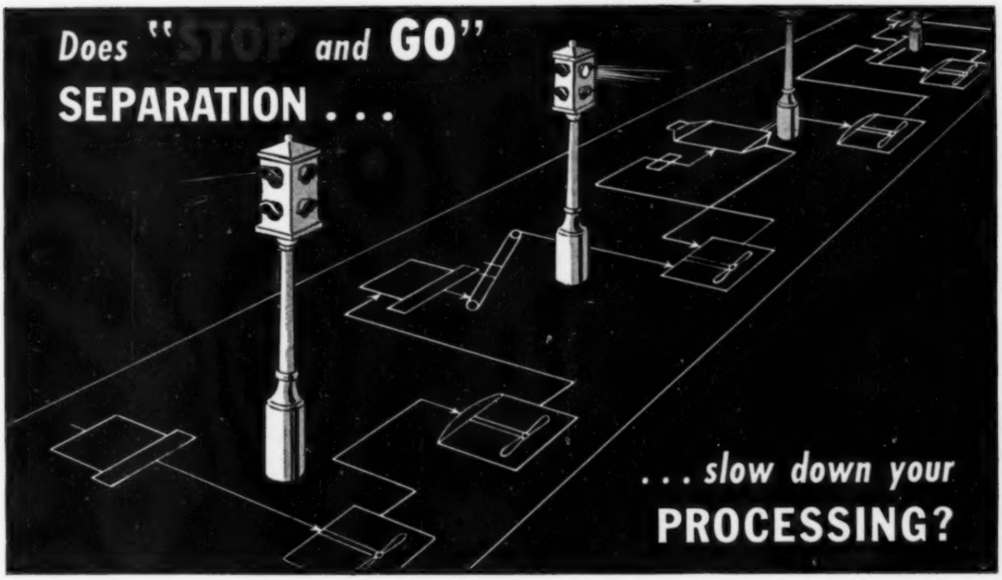
Gas from the process runs 600-900 Btu. per cu. ft., could be mixed with natural gas to give a 900-Btu. gas for heating use. Higher temperatures thermally crack tar to yield as high as 15,000 cu. ft. gas per ton coal. The Btu. rating drops with the increased volume, but the process is said to still give 25 percent more gas than coking processes.

At still higher temperatures water and carbon react to produce hydrogen and carbon dioxide. The CO_2 reacts with more carbon to give CO. This accounts for the 20 percent CO content of this gas which may be compared with the 4-10 percent CO of coke-oven gas.

Sulphur comes off mainly as H_2S, can be removed by the Girbitol or similar processes. Recovery up to 77

Pilot plant is expected to multiply usual coking rates 4 to 6 times.

* Patents pending.



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Sometimes De Laval centrifuges will reduce a separation process that once took minutes to a few seconds. Moreover, in making a separation continuously, these machines frequently make a ***cleaner*** separation than could be effected by stop-and-go methods.

De Laval centrifugals come in many different types and sizes to enable each application for centrifugal force to be met exactly. In writing for information, outline your general problem to De Laval engineers.

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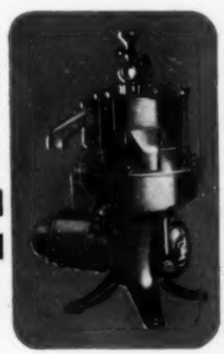


Pilot Plant Output Expected From a Ton of Dry Basis Coal

Temp., Deg. C	Char, Lb.	Tar, Lb.	Gas		Sulphur Lb.
			Cu. ft.	Btu.	
500	1,440	275	2,500	715	27
550	1,400	225	3,200	662	51
600	1,360	200	4,100	634	62
650	1,330	170	6,000	576	38
700	1,300	140	8,200	582	35
750	1,260	120	10,000	605	33
800	1,220	100	15,000	649	31

percent is possible, but rates are lower at high temperatures just as in coking (where 60-70 percent sulphur is retained).

▶ **King-Size Pilot Operation**—A 2-ton-per-hr. capacity is necessary to meet potential users' needs of 1,000-ton samples for blast furnace and other experimental use. Here is how Singh outlines the working of his unit.

Raw coal is ground, screened to -8 mesh, fed to a supply bin. Screw-fed from the bin to a rotary pressurized feeder, it is picked up and fluidized by process air and then carried to the oxidizer.

Resinous compounds which would cause troublesome agglomeration are largely destroyed by the 300 deg. temperature of the oxidizer. The oxidizer is heated by waste heat from the heat generator unit.

Oxidizer discharge is picked up and fluidized by process steam, then mixed with 25-70 percent devolatilized char and carried to the devolatizer. The hot char rapidly brings coal temperature up to the 500-800 deg. C. devolatilization temperature, driving off tar, gas and H_2S.

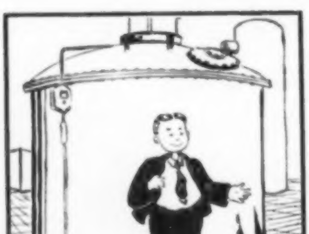
Char from the devolatilizer is picked up and fluidized by process air, carried to the heat generator. Partial combustion of tar here provides heat for the process. Some char recycles to heat the oxidizer discharge for devolatilization, the balance discharges as product char for boiler furnace, briquetting or as a coking material for blast furnace use.

Cyclones strip the char particles from tar and gases before they enter the pitch separator. Insulation maintains them at fluid bed temperature to prevent condensation and plugging. Cyclones on the oxidizer and heat generator units also prevent char loss to atmosphere.

Pitch is drawn off to storage from the bottom of the separator, oils near the top, while the gas passes to a condenser unit, then to a gas-liquor separator. Final traces of liquor are stripped from the gas by electrostatic precipitation.

Gas can be sent through H_2S and CO_2 strippers for purification or directly to gas-holder. Naturally raw gas (not purified) is considerably lower in Btu. rating.

LITTLE BONER



The Wrong Pew

A simple operation was being demonstrated to several company officials in New York City. The chief engineer was on the spot to supervise it.

The plan was simply to pump a high-priced, heavy syrup concentrate from the mixing vessel to a hot-water jacket homogenizer that had just been put in.

Everything went smoothly, and the chief engineer was mighty proud of the way the operation was coming off. He even predicted that something new might well come from the demonstration for he discovered that the pressure reading on the line to the homogenizer was extremely low.

After all the syrup had been pumped in, the homogenizer was opened, so that the officials could look at the final product. What they saw was a homogenizer full of hot water.

The valuable syrup had been pumped into the water jacket and right down the drain!

The young engineer who sent us this little boner commented, "Hope you enjoy this half as much as I did!" If you have a true "little boner," why not send it to the Editor, *Chemical Engineer*, 330 West 42nd St., New York 36, N. Y.

Build Catacomb to Ease Maintenance Operations

Maintenance men at Union Oil Co.'s new $8 million research center in Brea, Calif., have easy access to air, gas, vacuum, cold water, steam, waste disposal equipment, telephone lines and other wiring.

For servicing these utility lines, the company has built under its laboratory buildings an all-concrete tunnel network, over-all length—1,855 ft., big enough to accommodate a maintenance truck. The tunnel is particularly useful for laboratories where servicing pipes are often moved about the lab.

Protein Plant May Solve World's Food Shortage

In ten years farmers throughout the world, to feed an increased population, will have to double today's production. But they will not be able to do it using present agricultural methods and present crops.

Mass production of more nourishing foods, whether new or exotic, probably offers the best prospect for solving a most urgent problem.

Recently Professor Richard L. Meier of the University of Chicago said that chlorella, a one-celled green water-plant, produced on a production-line basis, could supply much of the world's basic food needs. However, proper processing methods must be developed before this can be achieved.

Some chlorella, investigations already under way show, produce proteins. In quality they compare to the proteins produced by soybeans.

While their possible use in the U. S. is under study, they hold the most promise for the under-developed and over-populated areas of Asia. Japan is probably the most promising area in the East.

Here, experiments show that a variety of one-cell plants may be cultivated. In Japan, chlorella could produce 15 to 20 tons, dry weight, of protein per acre per year. This compares with about a ton of dry protein produced over the same period and area in ordinary agriculture.

Local inhabitants, agricultural planners believe, at first will reject a chlorella diet. Even in areas close to famine rations, new and unfamiliar foods are highly suspect.

Smoking, pickling or incorporating the dried protein from chlorella in other foods may weaken consumer resistance. In Japan, for example, the protein could be added to bean curd made from soybeans.

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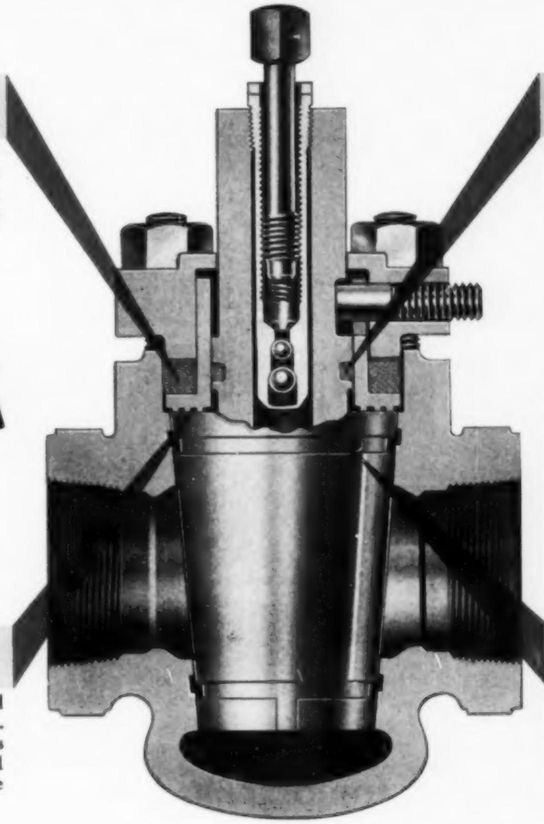

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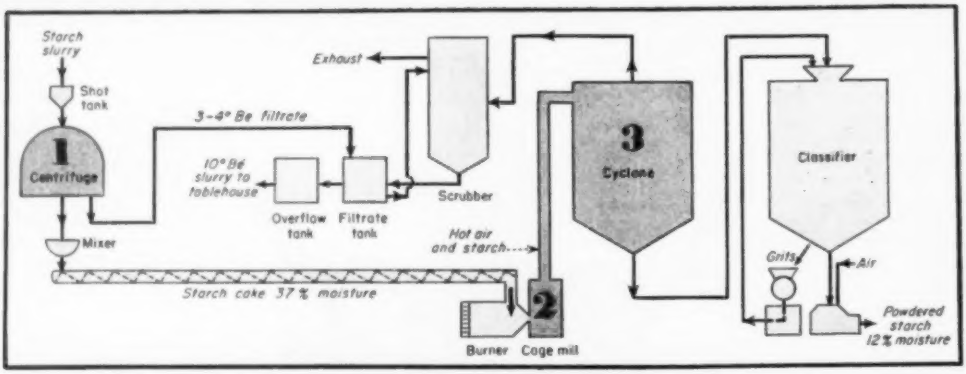
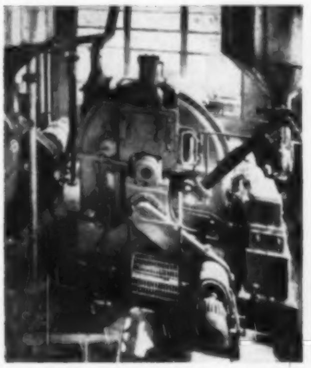
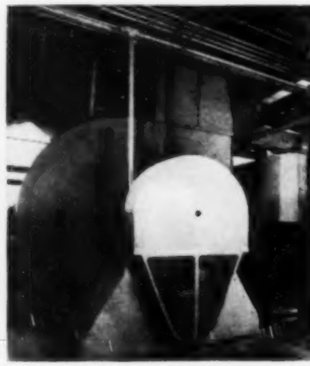




1 CENTRIFUGE: cuts water to 35%.



2. CAGE MILL: flash drys in 30 sec.

3 CYCLONE: separates starch from air.

Now Flash Drying for Starch

New use for flash drying is a major advance for the starch industry: hikes thermal efficiency of drying, cuts manhours 80 percent, gives a better product at lower cost.

Latest development in corn starch drying techniques is the commercial use of flash drying. The industry's first large unit has just gone into operation at the Roby, Ind., plant of American Maize-Products Co.

The new dryer has a capacity of 300,000 lb. a day and will boost Amaizo's starch drying capacity by more than 50 percent. Built almost entirely of 317 stainless steel, the dryer is the first step of a long-range modernization and expansion program that Amaizo started last fall.

▶ **Where Savings Are Made**—In comparison with the conventional kiln-type starch dryers, Amaizo engineers point out that their flash drying system requires less fixed capital, is cheaper to operate, turns out product at a higher rate, needs less operating labor and gives a product less likely to be contaminated.

Amaizo has one vintage kiln dryer staffed by ten men with an output of 100,000 lb. a day. But six men running the flash dryer will produce 300,000 lb. a day.

Thermal efficiency is better, too. Kiln dryers are fed with a filter cake of 45 percent moisture. But centrifuges cut the moisture of the flash dryer feed to 35 percent. Result: about a 30 percent savings in fuel.

In flash drying the starch is suspended in a stream of hot air and with large surface areas exposed; drying is almost instantaneous. In kiln drying the moisture must diffuse to the surface of the starch layer.

The new flash drying setup was worked out by Amaizo engineers in cooperation with the Raymond Pulverizer division of Combustion Engineering-Superheater, Inc. The dryer itself is a standard Raymond unit modified to Amaizo's specific needs.

▶ **How It Dewaters**—Starch slurry (23 deg. Be.) passes through a nylon-filter shaker and into a 3,000-gal. supply tank. Slurry from the supply tank is pumped to shot tanks above the Baker-Perkins automatically controlled, basket-type centrifuges (see cut). Each charge to the centrifuge overflows the basket for a short while, flushes yellow protein layer from the inside of the basket. Overflow slurry recycles back to the supply tank.

Centrifuges spin at 850 rpm., dewatering the slurry to a 32-40 percent moisture cake in 3-4 min. A knife cuts the cake, drops it into a conveyor feeding a Sprout-Waldron mixer. The complete centrifuging cycle from filling to cake cutting is only 16 min. Slurry filtrate (3-4 deg. Be.) recycles back to the supply tank.

The mixer equalizes moisture con-

tent of the centrifuge discharges to about 37 percent, feeds through a screw conveyor to the cage mill—heart of the process (see cut). A large rotor in the cage mill mechanically agitates the starch, disperses it in the hot air stream, prevents formation of lumps.

Air, drawn in at a rate of 28,000 cfm. and heated to 600 deg. F. by a bank of gas burners, dries the starch particles almost instantaneously, then carries them to the stainless steel cyclone.

The stream enters the cyclone tangentially at the top. Centrifugal force thus set up throws the starch particles against the wall and they drop into the hopper. Hot air, freed of starch particles but carrying vaporized moisture, passes out through the top of the cyclone.

Drying of the starch is almost instantaneous; about 80 percent of it takes place during the 30 sec. or less that the starch is in the cage mill. Close to 15 percent takes place in the duct leading to the cyclone, only 5 percent or less in the cyclone itself.

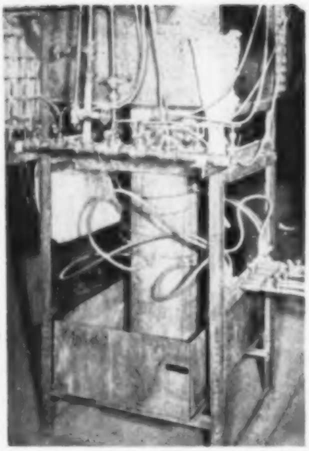
Cyclone discharge feeds through an air lock into the classifier where any degree of fineness can be obtained. Larger particles are sent to a screen hammer mill, crushed, then fed back into the classifier to go into finished product. The finished powdered starch is blown to the bagging department by a Fuller-Kinyon pump.

To prevent the loss of starch fines to the atmosphere, moist air from the cyclone passes through a Schneible multi-wash scrubber. Here baffles give the air a tangential flow as it rises through the scrubber. Recycle slurry (3-4 deg. Be.) from the filtrate tank flows down countercurrent to the air, wets the scrubber's inner surface. Starch particles contacting the water are wetted, bring the slurry up to 5-10 deg. Be. This is returned to the filtrate tank and recycled.

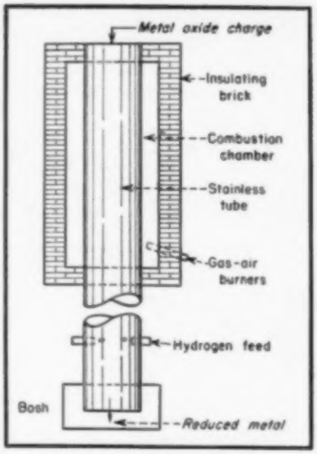
The stainless steel scrubber recovers about 3 percent of the starch that otherwise would be lost as fines.

Amaizo's new flash dryer is housed with a new building material known as perlite panels. These are made from expanded volcanic glass, portland cement and welded steel mesh reinforcing. Precast in 20-ft. by 16-in. slabs, the panels look like concrete. Though only 6 in. thick, they are equivalent to a 15-in. brick wall in insulation value.

Industrial uses of starch have outstripped food uses and it is in this field that Amazio expects to get new business for its expanded output. Textiles, paper, adhesives, dyes, insecticides, explosives, plastics, paints and mining operations will require more starch as defense gets rolling this year.



PILOT unit reduced 20 tons of ore.



SIMPLE design marks pilot furnace.

Hydrogen Tube Reduces Oxides

Recent pilot plant work shows that metallic oxides can be reduced continuously with hydrogen in a simple furnace. Close temperature control is vital.

Few commercial processes for reducing metal oxides use hydrogen as the prime reducing agent, and most of them are batch operations.

But hydrogen can be used to advantage and many of the processes could be made continuous. So argues Carle R. Hayward, professor emeritus of process metallurgy at Massachusetts Institute of Technology, who backs up his arguments with results from his own recent semi-pilot plant work. Hayward's points:

- Hydrogen is a better reducing agent than many of the mixed gases now used in blast furnaces and other metallurgical processes;
- Continuous hydrogen reduction of iron oxide – and probably other metal oxides–can be carried out without sticking of the charge if temperatures are closely controlled;
- Continuous hydrogen reduction can be highly mechanized to cut down labor costs over present batch operations;
- Continuous hydrogen reduction could often be competitive in costs to other methods now used;
- It's high time that the metallurgical industry takes a good look at what hydrogen has to offer.

Hayward's work culminated in semi-pilot plant runs on various iron oxide ores, nickel-copper concentrates, roasted pyrites, tin concentrates and other oxides. He believes that his simple tube-like furnace (see cut) could easily be adapted to continuous reduction of many metal oxides.

Although no commercial firm has yet stated its intentions of taking up Hayward's process, several helped finance the work. These include Metal Hydrides, Inc., Allegheny-Ludlum Steel Co., National Research Corp. and New Enterprises, Inc.

▶ **Continuous Pig Iron**—Many people have tried to develop an economical way to reduce iron oxides continuously. One of the many difficulties has been that high temperatures cause the charge to stick.

Hayward became convinced that hydrogen instead of carbon monoxide should be used as the principal reducing agent. Since hydrogen reduces at a lower temperature than CO, this sticking might be eliminated.

In 1948, with the help of Livingston Wright and Metal Hydrides, Hayward reduced some 20 tons of various iron oxides in his continuous hydrogen furnace. With one high-grade hematite, lumps up to 2 in. could be completely and rapidly reduced at less than 950 deg. C.

Under certain conditions, an exothermic reaction took place in the reducing zone. Hayward found that the outside heating chamber was necessary to start up the furnace, but that its chief value was in controlling the exothermic reaction in the charge. One of the critical factors in the continuous furnace operation–and one of the secrets of its success–was close control of temperatures.

Hayward feels that a semi-commercial or pilot plant furnace should have a stainless steel tube that would give a reducing zone about 8 ft. high. With pre-heating and cooling zones, such a furnace should have a daily capacity of 20-25 tons of high-grade iron.

Charge could be fed in continuously (or at short intervals) with a trap feeder. Effluent gases could be dried and the hydrogen recycled. A device for continuous removal of reduced iron would be necessary. Automatic controls would make labor needs very small.

Continuous hydrogen reduction works best on ores with 60-65 percent iron. With such ores, he believes that hydrogen reduction would be competitive with the blast furnace followed by open-hearth or electric-furnace production of steel. Since the iron is free of carbon, the product would be attractive for low-carbon or carbon-free iron alloys.

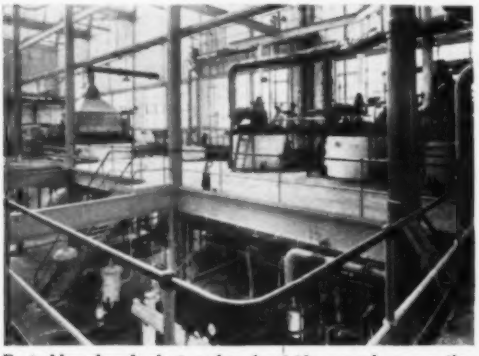
▶ **Hopes for a New Era**—Hayward's work now shows that many metals can be produced in a high state of purity by reducing their oxides in a hydrogen furnace. The techniques, he feels, would often be both technically and economically feasible on a commercial scale.

Continuous hydrogen reduction of metal oxides, Hayward points out, might well usher in a new era in many metallurgical and chemical operations.

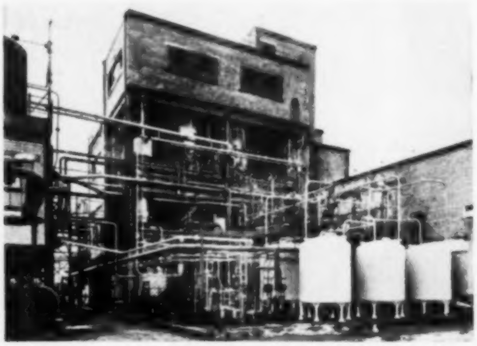
Designed for a Blowout

For safety sake, William S. Merrell Co., Cincinnati, has incorporated an unusual design feature in its new organic research laboratory. An explosion in the lab would blow out the ½-in. asbestos-like paneling. Solid inner walls confine any blast to one section of the lab.

Designed for integration and expansion, over-all project has system of overhead lines for raw materials, intermediates, services.



Pentachlorophenol plant makes fungicides, wood preservative.



Largest single unit so far is the synthetic detergent plant.

Giant Plant Cuts U.K. Imports

Many chemicals already made by the parent company in the U. S. are now being turned out for the first time in Britain by Monsanto Chemicals Ltd.

Synthetic detergents of the alkyl-aryl sulphonate group, polystyrene, pentachlorophenol and its sodium salt, oil additives, chlorinated polyphenyls—they're all made in Britain now, thanks to newly-completed plants of Monsanto Chemicals Ltd. in Newport. These $10 million units combined make up only a quarter of the eventual size of the project. Consequently, they are designed for continuous expansion.

▶Integration, A Keynote—Completely integrated and modern, they feature the best in British and American engineering and equipment. Chlorination plays an important part in a number of the manufacturing processes. Therefore a mercury cell plant of advanced design makes chlorine and caustic soda.

Almost all liquid raw materials and intermediates together with high and low pressure steam, water and compressed air run through color-coded pipelines on overhead gantries. Returns and sewers run underground. Standardized arrangement will enable services to be extended to new plants without disorganizing those already in operation.

Whenever possible, engineers have erected the units in the open without protecting walls. They've made full use of automatic control with a total of 4,000 instruments installed to date.

In physical size the largest single unit at present is for manufacturing synthetic detergents of the sodium alkyl-aryl sulphonate group. A closely controlled kerosene fraction is continuously chlorinated. Alkyl chloride is then reacted with benzene in the presence of a catalyst—again a continuous reaction. Hydrochloric acid evolved is recovered for use elsewhere in the plant. Reaction mixture is continuously sulphonated, then neutralized and dried.

The number of corrosion resistant vessels used in these processes give some idea of the practical difficulties involved. Some vessels are of solid nickel, others are lined with silver, or with enamel. Glass linings offer sufficient resistance in some of the reactions, but others require special containers of Monel metal. Certain of the storage tanks have to be lined with rubber.

▶Self-Sufficiency Near—Before Monsanto's Newport unit, the only large-scale source of polystyrene for British industry was the United States and Canada. Styrene monomer for the plant still has to be imported from the U. S. But by the middle of this year a jointly owned plant now under construction at Grangemouth, Scotland, is expected to start producing enough monomer for present and future use.

Right now only three main types of oil additives are produced at Newport. But the flexibility of the plant is such that sub-units performing individual operations (chlorination, sulphonation, neutralization) may be linked together in various ways to turn out blends of existing additive and new ones still under development.

The pentachlorophenol products are made by reaction of chlorine and phenol in the presence of a catalyst. Further reaction with caustic soda produces the sodium salt.

Most recent plant to be completed is that manufacturing diphenyl and chlorinated polyphenyls. The process involves the thermal condensation of benzene followed by chlorination, then carefully controlled fractional distillation to yield different grades.

News briefs . . .

Defense Materials: Beginning in the first quarter of 1952, defense needs will eat up more than 40 percent of the carbon steel and about 60 percent of the supplies of aluminum, copper wire mill and copper brass mill products.

Ammonia-Methanol: Two recent developments: Commercial Solvents Corp. will put \$20 million into additions to double plant capacity at Sterlington, La. Mathieson Chemical Corp. will operate the Army's Morgantown Ordnance Works, W. Va., under a five-year lease for the production of the two chemicals.

Steel Tubing: The plant of Babcock & Wilcox Co., Beaver Falls, Pa., is the first plant in the U. S. to turn out stainless steel tubing by the "Ugine-Sejournet" extrusion process. The process makes possible for the first time the extrusion of hollow and solid sections of metals that forge with great difficulty.

Safety: Monsanto's Everett, Mass., plant has operated 7 years without a lost-time accident.

Boilers: A new experimental high pressure boiler, capable of operation at 3,000 psi., has been developed at Michigan State College. The baby boiler (30 by 50 in.) is the only one in existence in the high pressure field that tests for metal failure, foaming and scaling, all at the same time.

Instruments: A vortex thermometer, developed by the Naval Research Laboratory (ONR), gives correct measurements of air temperatures at 500 mph. It uses an axial tube

in which a vortex is set up. Center of the vortex produces lowered pressure with cooling effect that cancels out heating effect of compression and friction.

Rubber: U.S. Rubber Co. is surveying the Southwest, plans to build a tire factory in the territory.

Insecticides: An economical method for detecting spray residues of the new chlorinated insecticides has been developed at the University of California's College of Agriculture. It involves changing the chlorine in the insecticide to sodium chloride and analyzing for chlorine in the salt.

Soybean oil: U.S. Department of Agriculture has come up with a process for removing the beany taste from soybean oil. This taste, due to the presence of highly unsaturated linolenic acid, is removed by saturating the acid.

Plastics: The Navy will install plastic piping in its new mine-sweepers, saving about two tons of copper per ship. Already tested, the pipe is made of fiber glass cloth bonded with synthetic resin, and can be patched with fiber glass tape impregnated with plastic.

Welding: Eutectic Welding Alloys Corp. has developed an electrode that can gouge, chamfer, clean and partially mill any metal or alloy. The new ChamferTrode has a heavy coating which forms a cone at the striking end of the electrode, providing a jet-effect arc.

Ordnance: Du Pont will rehabilitate and operate the Army's Indiana Ordnance Works at Charlestown, Ind. Propellent powders for artillery and small arms ammunition will be manufactured at the plant.

Fertilizers: Sulphuric acid can reclaim soils too high in alkali, according to Roy Overstreet, soil chemist at the University of California at Los Angeles. Soils treated three years ago are still highly productive. Overstreet claims such treatment may be economically profitable.

Pulp: Celanese will process pulp into flake and yarn at its new Canadian Chemical Co. plant at Edmonton.

Education: Senior chemical engineering students at Tulane University can now receive 18 hours credit, the equivalent of a full semester's work, in a new training course conducted in conjunction with the Pan-Am Southern Corp. at New Orleans. The students put in an eight-hour day, five days a week at the company's Destrehan refinery.

Readers' Views & Comments

Our Roll of Honor (Tentative)

● In a January editorial we told you about our plans to include a special Roll of Honor in the Golden Anniversary issue of this magazine. On that roll we intend to list the names of those in each of the 48 states who have the longest records as continuous subscribers to *Chemical Engineering* and its various predecessors.

● Unfortunately the early files of our Subscription Department were lost so we had to turn to you readers for help and guidance. Already we have had a gratifying response—but many states are still to be heard from. And we want to make sure that we don't overlook any subscribers with longer records than those cited in the following correspondence. If you're in that category, let's hear from you—promptly.

Colorado

Sir: Our technical library, which has been under my personal supervision most of the time since 1915 has been a continuous subscriber since April 1915. While I have not personally been a continuous subscriber, I do have my own personal bound copies of *Electrochemical and Metallurgical Industry* for the period October 1907 to June 1909—my junior and senior years at the University of Minnesota.

HENRY W. DAHLBERG
Director of Research
The Great Western Sugar Co.
Denver, Colo.

Connecticut

Sir: I started by subscription to *Met. & Chem.* in 1913 or perhaps a year earlier. I continued until my company started a service in technical periodicals (which I organized). In all these years with *Met & Chem.*, *Chem. & Met.*, and finally, *Chemical Engineering*, I've kept abreast of progress, got some education and a lot of ideas.

KARL E. PEILER
Hartford Empire Co.
Hartford, Conn.

Canada

Sir: Unless someone else has subscribed continuously since the first number (September 1902), I am your oldest. I have not only subscribed from the start but I had all the numbers from the first one to 1935 bound, and I donated them to the Royal Military College at Kingston, Ont., where they were put in the library. My son-in-law, the late Gen. H. H. Mathews, was Commandant at the time.

ERNEST A. LESUEUR
Ottawa, Ontario

► *So far no one has come close to matching this record of Canada's 82-year-old pioneer electrochemist and distinguished inventor—*ED.

District of Columbia

Sir: Going purely by memory, I would say that I have been a subscriber directly or indirectly to *Chemical Engineering* and its predecessors since 1911. In any event I have been a reader of practically every issue since that time and perhaps a little earlier. . . . I may mention that around 1905 or 1906 I became associated with the late K. P. McElroy, who was a chemist and patent attorney, and one of your very earliest subscribers.

I assume it was purely through inadvertence that you are limiting your Honor Roll to old-time subscribers in each of the 48 states. Although by law a resident of the District of Columbia is a political eunuch, I would feel somewhat slighted if I were not taken into consideration.

A. M. HOUGHTON
Patent Counsel
Gulf Oil Corp.
Washington, D. C.

► *Our editorial apologies, Mr. Attorney, and our political sympathies. We were once that way ourselves.—*ED.

Georgia-I

Sir: We started our subscription in May 1921. The progress that has been made by the chemical industry is really remarkable and we feel that your magazine has kept us up with that progress and has been very informative in describing new developments and processes. . . . We wish you even greater success during the next fifty years—when there will doubtless be many opportunities to enlarge your services to the ever expanding chemical industry.

P. C. CROWELL
Armour Fertilizer Works
Atlanta, Ga.

Georgia-II

Sir: Chemical Engineering has commanded a prominent position in our library since our original subscription in June 1920.

G. CONNER HENRY
Law & Co.
Atlanta, Ga.

► *This too close for comfort. But are there any other Georgians to be heard from?—*ED.

Illinois-I

Sir: I am not certain about the month but have been a continuous subscriber since 1910. I have been a member of ACS since 1905 but have found your journal a fine addition for one engaged in chemical engineering and manufacturing.

E. F. BUCHANAN
Consultant
Chicago, Ill.

Illinois-II

Sir: I have been a continuous subscriber since 1911 starting with *Met. & Chem.* My first goal after receiving my degree at Wisconsin in June 1910 and after arriving broke in Pittsburgh for my first job was to join the American Electrochemical Society and to subscribe to your magazine. I did this just as soon as any surplus cash jingled in my pocket.

A *Met. & Chem.* subscription was a "must" for me because my professor, the late Dr. Charles F. Burgess taught us the value of that publication in his chemical engineering and applied electrochemistry courses. It served as our textbook much of the time. Those of us who had to pinch pennies in our

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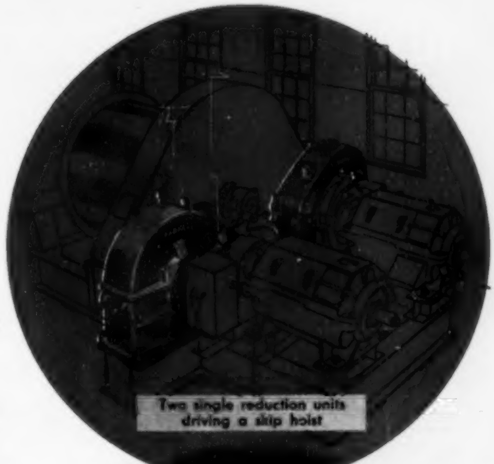
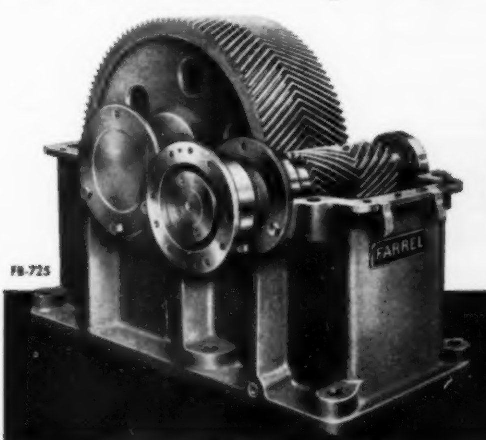


Two single reduction units driving a skip hoist

Single reduction unit driving a rolling mill

Double reduction unit driving rotary kiln in cement mill



FB-725

undergraduate days did not subscribe then but used the Engineering Library's copies. That free service cut a few years from my continuous subscriber record.

Oliver W. Storey
Burgess Battery Co.
Chicago, Ill.

▶ *Again we'll need the wisdom of a Solomon unless there's a still earlier contender among the Illini.*—Ed.

Iowa

Sirs: I have been a subscriber continuously since October 1922. The Serials of the State University of Iowa have the journal complete from the first issue in 1902 but I am not certain whether copies were obtained by purchase or gift. One University subscription dates from 1909. You will have to decide for yourself whether the State University of Iowa is your oldest institutional subscriber in the state of Iowa or whether I have the honor of being the longest personal subscriber.

Edward Bartow
Professor Emeritus
Chemistry & Chemical Engineering
State University of Iowa
Iowa City, Iowa

Kansas

Sir: In the course of the passing years it had not previously occurred to me that I have been a subscriber to *Chem. & Met.* since May 1924. During these years of service the coverage of the technical angles of the various types of industry has been most interesting. In many cases your magazine has provided the means of integrating underlying principles into other industrial pursuits than those for which its articles were originally written. Furthermore we have had the advantage of keeping in touch with the latest and best features of engineering materials and equipment through your advertising pages.

I congratulate you and your staff in maintaining the high level of excellence that has made possible fifty years of essential and appreciated service.

G. E. Prewitt
Ozark Smelting & Mining Co.
Coffeyville, Kan.

Kentucky

Sir: I think our record as a subscriber may date back to 1920 instead of 1925 as reported by your Circulation Department. We consider *Chemical Engineering* an important source of information and hope to be

on your subscription list for many many years to come.

J. D. Todd
Vice President and General Manager
Kentucky Color and Chemical Co.
Louisville, Ky.

Louisiana

Sir: We sent you our first check in July, 1924. Editor Kirkpatrick was here in the late 20's to prepare an article on our process which you published with pictures of our plant.

C. C. Boardman
Thermatomic Carbon Co.
Sterlington, La.

► *Well do we remember our discussion then about using waste hydrogen for synthetic ammonia. We were just about twenty years ahead of time.*—Ed.

Missouri

Sir: Re your editorial in January, I wish to enter my name among your long-time continuous subscribers. In 1907 I first became a subscriber to *Electro-chemical and Metallurgical Industry* and have continued without interruption ever since. . . . My address has changed many times since I first subscribed as a student of engineering at Armour Institute of Technology in Chicago (now Illinois Tech) but my interest has never lagged in processes and materials as well as equipment for chemical industry. *Chemical Engineering* rates tops with me.

Garrett B. James, Sr.
Webster Groves 19, Mo.

Pennsylvania-I

Sir: I am not at present a paying reader of *Chemical Engineering*. However, I am one of those who paid to get the first copy of what used to be known as the *Electrochemical Industry* which was published by the Electrochemical Publishing Co. of Philadelphia, Jos. W. Richards, president and E. F. Roeber, editor. I have all the succeeding volumes down to about 1930 or maybe a little later.

The formation of the American Electrochemical Society and the publication of your journal changed my whole life course. I became so interested in the possibilities that after the second meeting in New York I decided to go to the University of Wisconsin to study under Dr. Charles F. Burgess. So I resigned my job with General Chemical, even though I was informed I was soon to be the senior cadet works chemist and in line for a works management job. Otherwise I very likely would not have landed with Du Pont as I did after a couple of years at Wisconsin. Since

then I've had a ring side seat at the greatest show on earth—if you get what I mean. Keep up the good work.

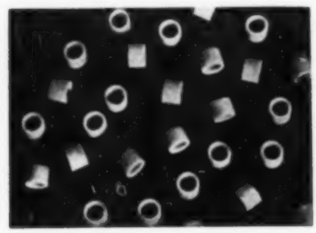
GEORGE M. NORMAN
Technical Director (retired)
Hercules Powder Co.
Fairville, Chester County, Pa.

Pennsylvania-II

Sir: My subscription began with Volume 3 of *Electrochemical Indusary* and has been continuous ever since.

FRANCIS C. FRARY
Director of Research (retired)
Aluminum Co. of America
New Kensington, Pa.

► *One solution to this problem is to put George Norman on the ballot for Delaware—pending investigations now under way in the Du Pont, Hercules and Atlas companies. Besides, in Dr. Frary's case it's been a continuous reaction.*—ED.



Catalyst Support?

Sir:

I have read your report for December 1951 which described the selection, manufacture and recent applications of catalysts.

In it the following statement was made: "There is a growing need for catalyst supports which are chemically inert, mechanically strong, and abrasion resistant."

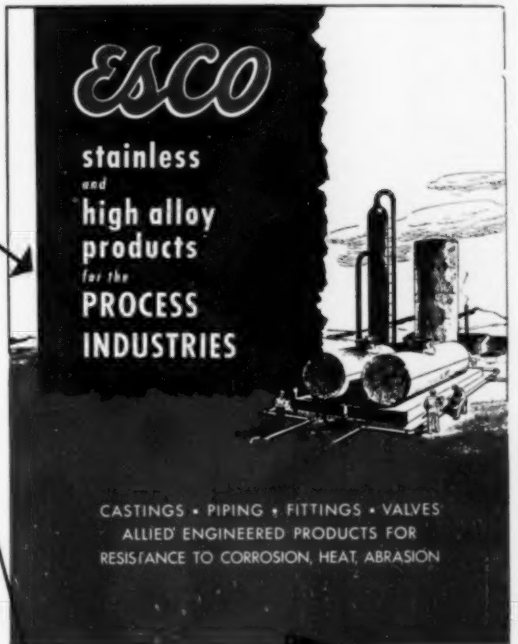
I believe that we can adapt one of our products (see *cut*) to meet all of the requirements for a catalyst support.

These supports are made of "Pyrex" glass which I am certain meets the requirements of being chemically inert. The design can be changed slightly to improve the mechanical strength. The supports, being made of glass, are abrasion resistant. Inspection under a microscope will show the surface of the support to be very porous.

We are a young organization formed recently for the manufacture of pressed and sintered products made of powdered metal, powdered glass, and plastics. At present we have idle

a new guide to better operation

through effective resistance to corrosion, heat and abrasion



Here's a brand new catalog containing detailed information on stainless and high alloy equipment that will help you overcome the problems of corrosion, heat and abrasion in your plant.

In addition to an explanation of the different types of corrosion and recommended analyses for meeting the various corrosion problems, the catalog includes data on the following:

- **Heat resistant castings**
- **Abrasion resistant castings**
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- **Dimensions on screwed, flanged and welding fittings**
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- **Corrosion and heat resistant conveyor chains**
- **Wrought stainless pipe, tubing, light wall fittings**
- **Useful tabular data on bars, tubing, fittings, etc.**
- **Corrosion resistance of principal alloys to most common corrosive agents**

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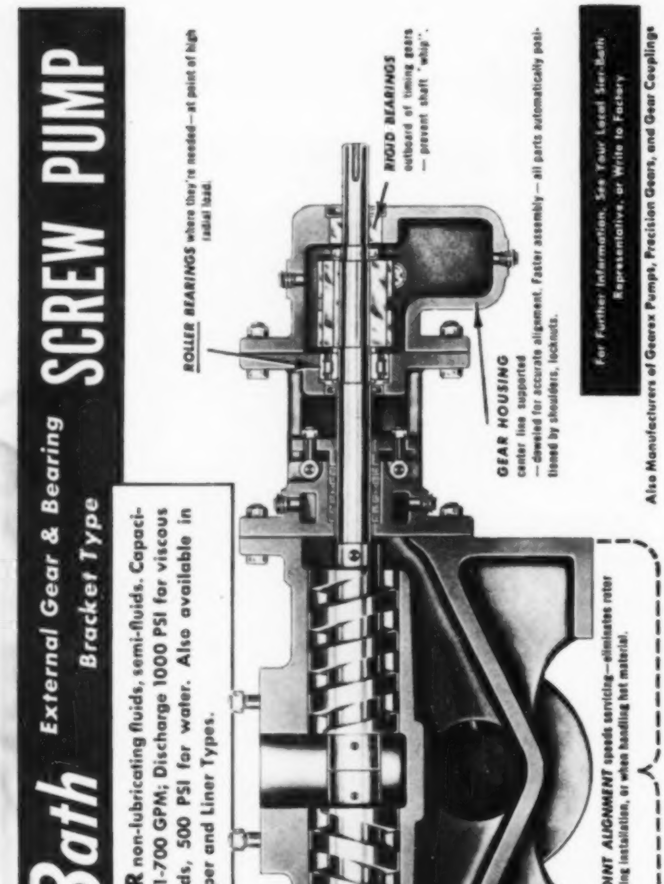

production capacity for the manufacture of these products.

W. E. SMITH
PreSint Products
Lyndhurst, Ohio

▶ *The photograph above shows the pressed glass new product that Mr. Smith believes has possibilities as a catalyst support.—*ED.

More Pollution Control

Sir:

This is a rather belated comment concerning your special section on "Pollution Control" which you published last year.

I think this is an excellent group of articles and fills a need which has not been completely covered in the past.

HAMNETT P. MUNGER
Chemical Engineering Division
Battelle Memorial Institute
Columbus, Ohio

▶ *Our recent talks with pollution control officials, both state and federal, convince us that the chemical process industries can expect greater emphasis on pollution control in the future. Some officials are about ready—and evidently eager—to crack the whip.—*ED.

For Meritorious Advertising

Sir:

You and your readers may be interested to learn that officials of the chemical and chemical equipment manufacturing industries of New England are actively participating in our organization's efforts to promote and recognize high-quality advertising in industrial and professional publications. . .

Several of these officials will serve as judges in our 1952 Contest . . . and on April 8 will present awards to winning companies and their agencies.

CONTEST MANAGER
Associated Business Publications
New York, N. Y.

▶ *We commend these efforts to stimulate higher quality advertising in business and professional publications. We're especially glad to see active participation by these members of the chemical and process equipment manufacturers of New England:*

Russell L. Miller, plant manager, Monsanto Chemical Co., Everett, Mass.; Calvin A. King, chief development engineer, Bird Machine Co., South Walpole, Mass.; Lawrence F. Blackwell, vice president in charge of production, Pneumatic Scale Corp., Norfolk Downs, Mass.; Austin Secor, purchasing agent, Dewey & Almy Chemical Co., Cambridge, Mass.; W. W. Frymoyer, factory manager, Foxboro Co., Foxboro, Mass. —End


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OLIVER

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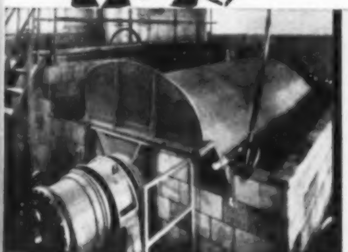
Don't let the pH scare you!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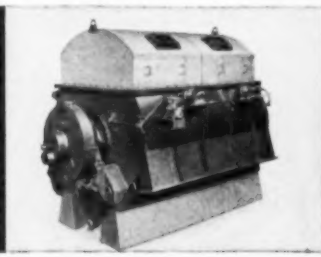
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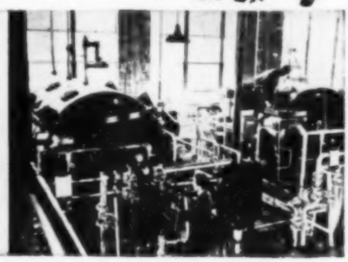

c.

Two fundamentals always are involved in the problem of separating solids from liquids, whether or not washing is involved:

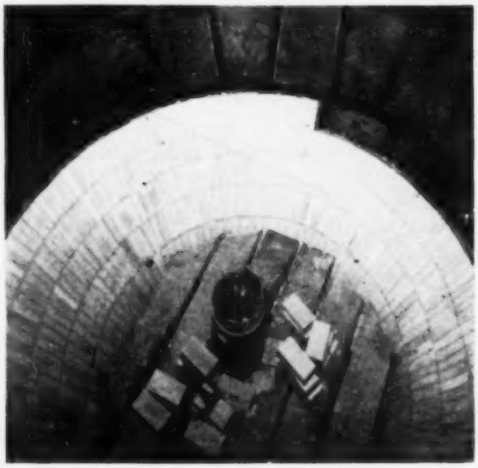
1. filtering characteristics of the pulp being handled.
2. corroding characteristics.

Bring your problem to Oliver United. Our experienced engineers will be glad to work with you on determining (a) the best type of filter and (b) the best corrosion resisting material to use in its construction.

That we are in a strong position to help you is evidenced by the fact we have served industry along these very lines for forty-five years . . . that we are experienced in every class of filtration . . . that we have many types of filters from which to select (continuous vacuum, continuous pressure and batch pressure) . . . and that we have the design and manufacturing facilities to construct filters of any available corrosion-resisting material.

So, as we say, don't let the pH or balky filtering characteristics of the pulps scare you. We can get you just the right filter.

The Corrosion Forum **Edited by Morgan M. Hoover**

Applications of silicate cements: joining of bricks in a chromic acid reaction tank (left), and in an alum tank (right).

Silicate Cements

For your files: the corrosion resistance of silica-filled chemically-setting silicate cements which will withstand higher temperatures than furane, phenolic, and sulphur cements.

RAYMOND B. SEYMOUR & ROBERT H. STEINER
The Atlas Mineral Products Co., Mertztown, Pa.

Chemically-setting silicate cement is one of the oldest corrosion resistant materials used industrially. In the preparation of this type of cement, it is common practice to add approximately two parts by weight of powder to one part by weight of silicate of soda liquid in order to form a trowelable mortar. This mixing is done on the job and the mortar must be used while it is still in a workable state. As in the case of resin cement mortars, the working and setting times decrease as the temperature increases. A working time of 35 min. and a setting time of 36 hr. at 77 deg. F. may be considered typical.

Filled silicate cements which set by evaporation only have been replaced almost completely by the chemically-setting type but are still used occasionally. The data presented with this article are for silica-filled chemically-setting silicate cements.

The sodium silicate liquid used for a silicate cement mortar should have a specific gravity of 35-40 deg. Be. and a ratio of sodium oxide to silica of 1:3.2-3.9. The resulting cement, when set, should have the following physical properties:

Physical Properties of Silica-Filled Chemically Setting Silicate Cements

Tensile strength, psi.—77° F.	350
500° F.	300
750° F.	250
1,000° F.	50
Compressive strength, psi	2,500
Modulus of elasticity, psi	750,000
Adhesion to brick, psi	100
Coefficient of expansion, per ° F.	6.2×10^{-6}
Water absorption, %	8-15
Apparent porosity	20-25

As indicated in the accompanying data, silicate cements are resistant to all inorganic acids in all concentrations except hydrofluoric acid. Silicate cements are not suitable for aqueous solutions at pH's above 7 and because of their high porosity, they should not be used in the presence of crystal forming systems. Obviously, the formation of crystals within the porous silicate structure can cause spalling of the cement.

The temperature limitations of silicate cements are somewhat controversial since, as indicated in the above table, the tensile strength of silicate cements decreases rapidly above 750 deg. F. Vitrification takes place at somewhat higher temperature and while the strength is regained after the structure has fused, few structural designs can withstand this change of state. However, circular brick structures joined with silicate cements have been used successfully at temperatures above 1,000 deg. F.

Notice . . .

This is the fourth in a series of chart data presentations giving corrosion data for various materials of construction vs. a number of corrosives. Data for the corrosives of particular interest to you will be increased as the coverage grows to include all of the major materials of construction.

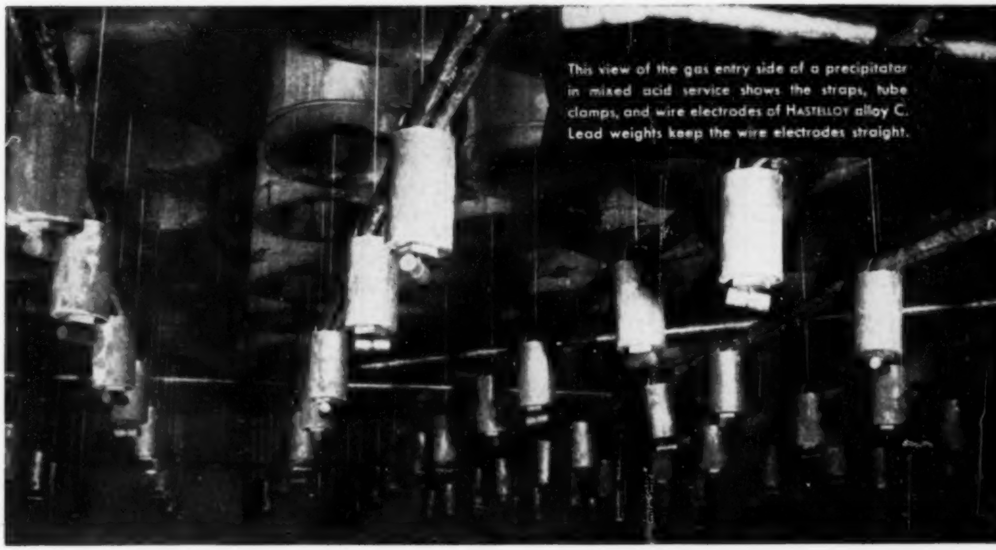
Coming:

Tantalum, April 1952
Aluminum, May 1952

Already Published:

Furane Cements, December 1951
Phenolic Cements, January 1952
Sulphur Cements, February 1952

Reprints of the series already published are available at 25c. each. Address Editorial Dept., Chemical Engineering, 330 West 42nd St., New York 36, N. Y.



This view of the gas entry side of a precipitator in mixed acid service shows the straps, tube clamps, and wire electrodes of HASTELLOY alloy C. Lead weights keep the wire electrodes straight.

Precipitators Improved... WITH NICKEL-ALLOY ELECTRODES

Electrostatic precipitators for removing corrosive liquids and solid particles from industrial process gases give better and longer service, without maintenance, when HASTELLOY alloy wire is used for electrodes. The alloy has excellent mechanical strength (130,000 psi) and is not attacked by the corrosive agents. This combination of properties makes it possible to use electrodes that are only 0.073 in. in diameter. The effective diameter of the lead-covered wire formerly used in most units was more than 0.500 inch. The smaller cross-section of the HASTELLOY alloy wire permits the use of higher voltages with a more uniform corona pattern.

HASTELLOY alloy C electrodes have been installed in mist precipitators where hydrochloric, sulphuric, sulphurous, and mixed acids were present. A recent check on an installation in an acid plant showed that the alloy C wires experienced no weight loss after a year's operation. Lead-covered steel wires, on the other hand, lasted an average of 11 months with electrode failure at least once a week.

For information on wrought forms of HASTELLOY alloy, write for the booklet, "HAYNES Wrought Alloys Price List."

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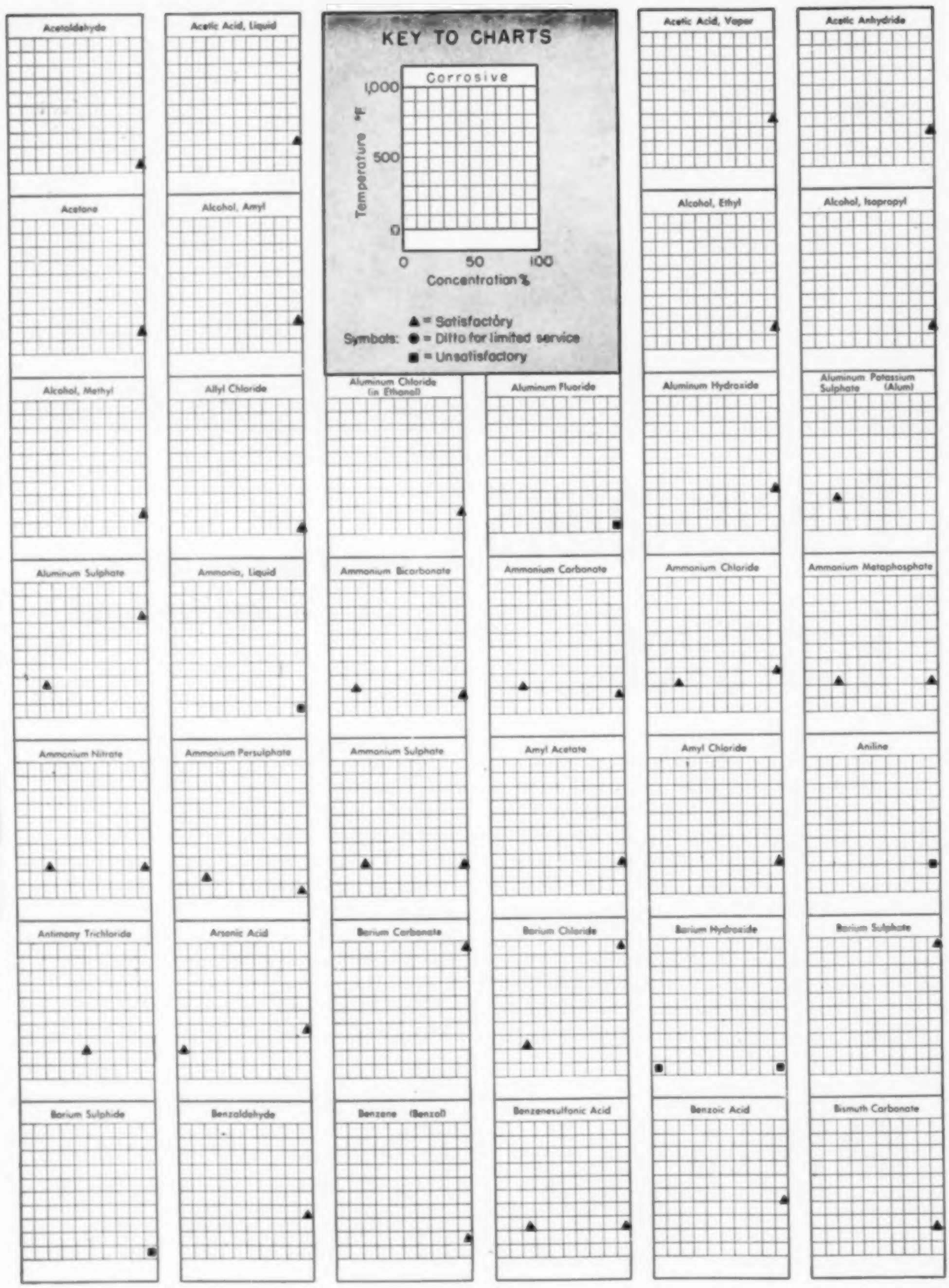
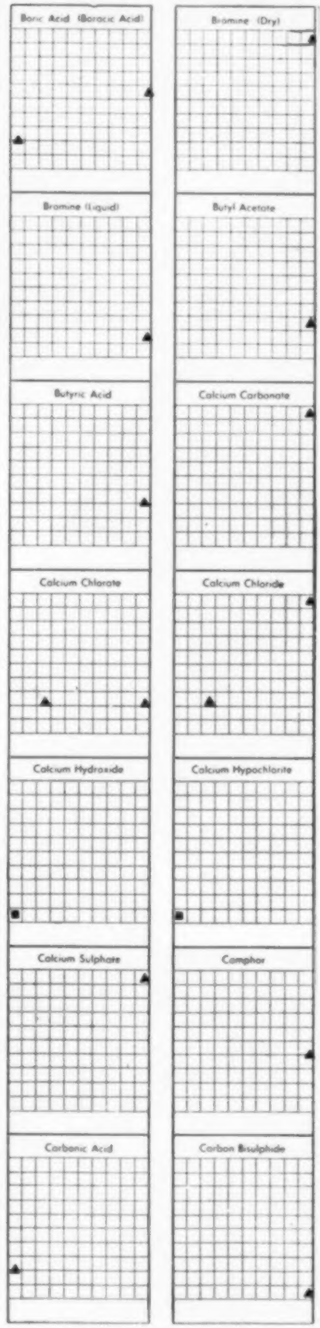
Corrosion Resistance of Silica-Filled Chemically-Setting Silicate Cements



Silicate Cements (key on p. 270)



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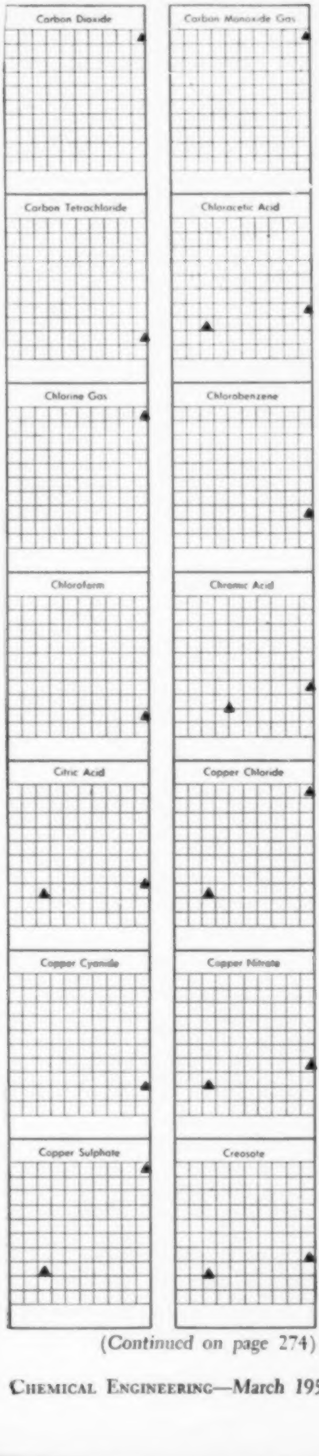

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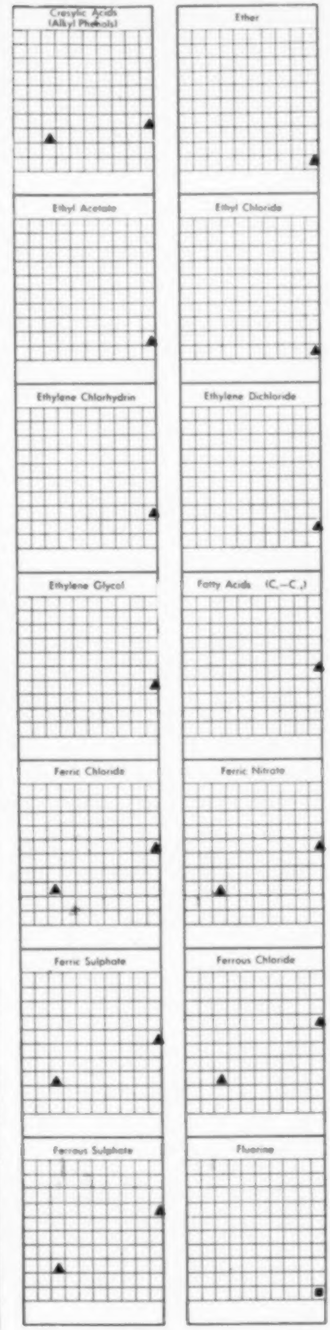

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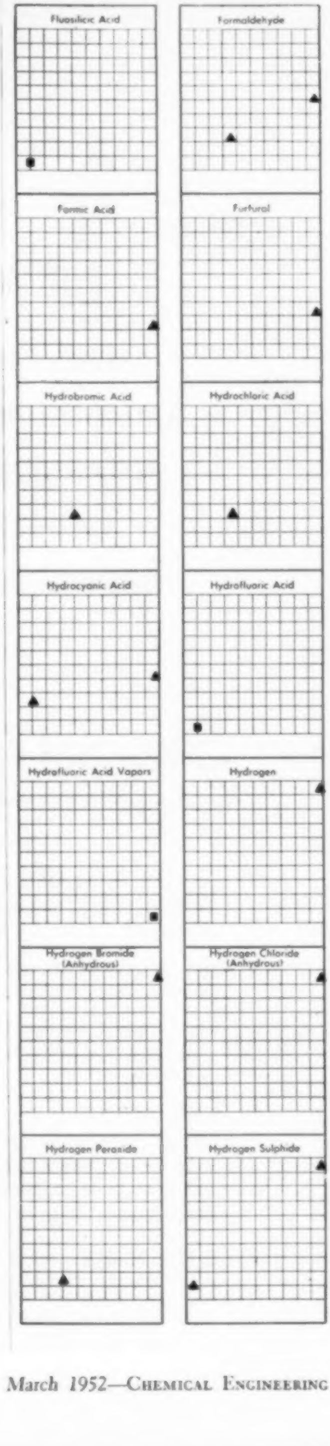

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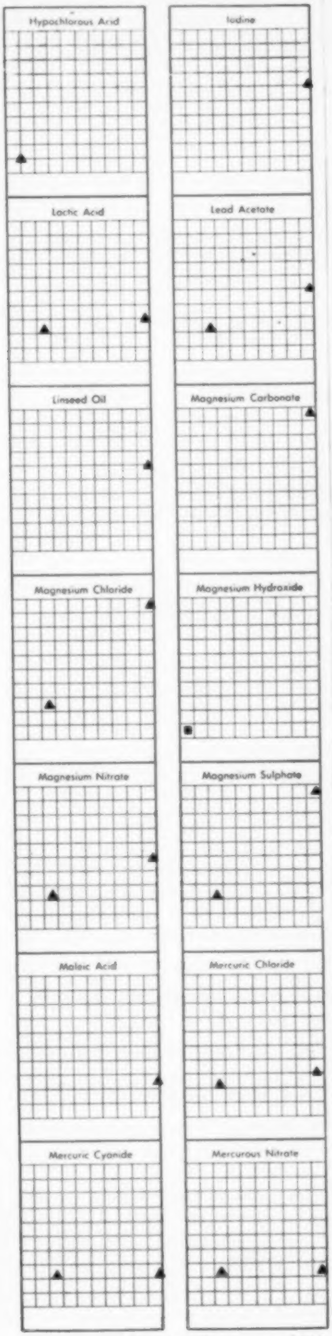

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Corrosion Forum, cont. . .

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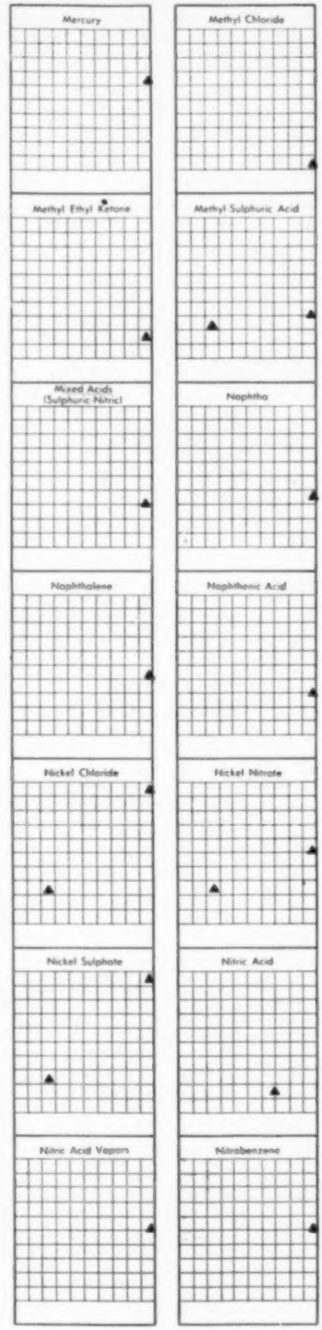

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Corrosion Forum, *cont.* . . .

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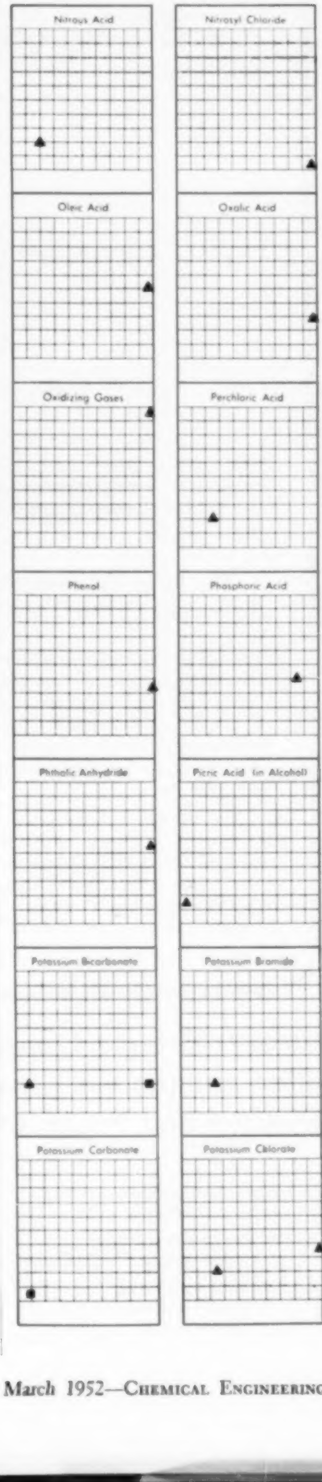

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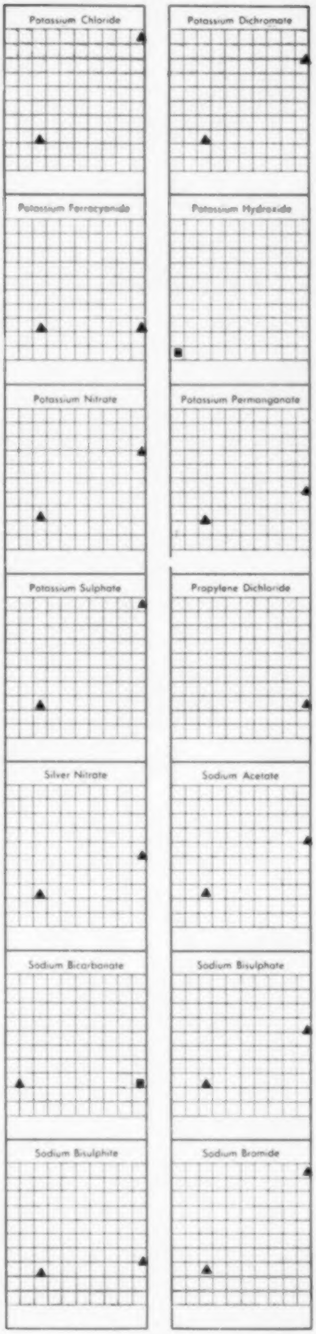

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Corrosion Forum, *cont.* . . .

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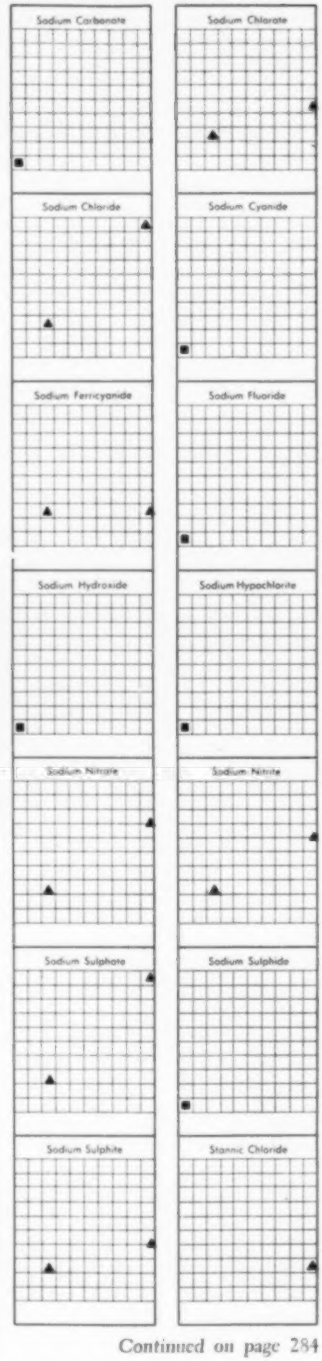

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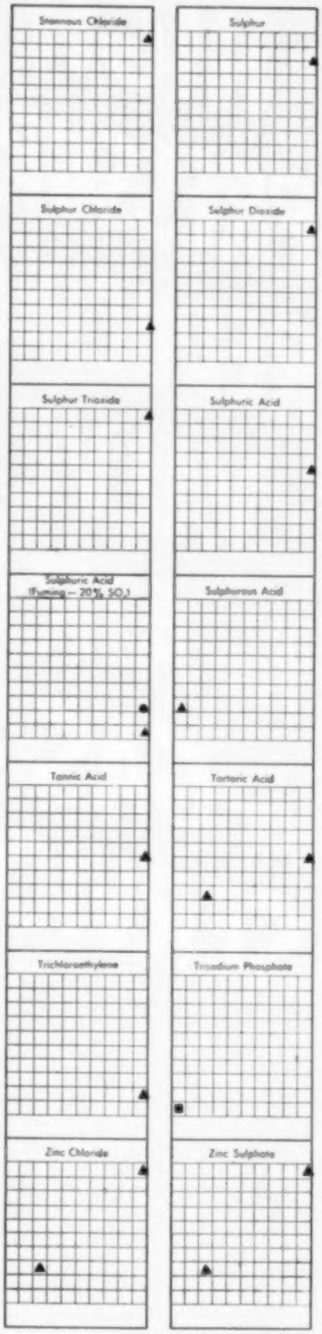
CORROSION FORUM, cont. . .

Silicate Cements (key on p. 270)



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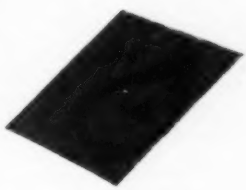

Boltaflex Poinsettia Pattern

DiButyl Phthalate
DiIsoOctyl Phthalate
DiOctyl Phthalate
DiIsoOctyl Adipate
DiOctyl Adipate
DiButyl Sebacate
DiIsoOctyl Sebacate
DiOctyl Sebacate
TriCresyl Phosphate
TetraHydroFurfuryl Oleate

PLASTICIZER DIVISION

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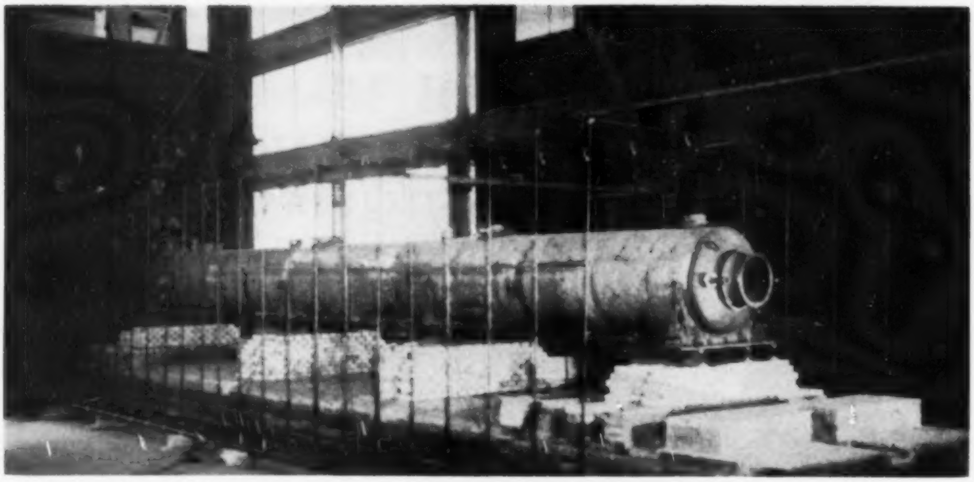


Fractionating column ready for heat-treating furnace where chromium carbides formed by heat of welding will be put back into solid solution. Sprays will cool through sensitization range fast enough to prevent reforming of the chromium carbides.

Preventing Intergranular Corrosion Due to Welding Stainless

A refresher on the merits of the three principal ways—and reasons why heat treatment is often better than the use of stabilized and extra-low carbon stainless steels.

Diversion of columbium—formerly available as a stabilizing agent—to high strength and heat resistant alloys is only one factor favoring the heat treatment method.

STANLEY C. ORR, Chief Ceramist and Metallurgist, Elyria (Ohio) Div., The Pfaudler Co.

During present material shortages it is important that users of welded stainless steel equipment review some of the well established methods of heat treating and stress relieving stainless steel.

Heat treated unstabilized stainless steels can often replace the more critical stabilized stainless steels. Carbide precipitation during the welding of unstabilized stainless steel causes a decrease in chemical resistivity in the heat affected zone. Columbium and titanium stabilized stainless steels have commonly been used to overcome this deficiency. Proper heat treatment of the unstabilized 300 series stainless steels, however, can restore the chemical resistivity of fabricated equipment for chemical service to a degree comparable to that obtained with the critical stabilized materials.

ROLLS OF ALLOYING ELEMENTS

Carbon—Among the most important alloying agents in stainless steels is carbon. Its importance however, lies in the undesirable influence it has upon stainless steel. It is present largely by sufference since it cannot entirely be eliminated from ferrous alloys.

When austenitic stainless steel having a carbon content in excess of 0.03 percent is heated within the range of 800 to 1,600 deg. F., the carbon tends to migrate from its solid solution within the austenite grains to the grain boundaries. Here it combines with from 10 to 30 times its weight of chromium forming a complex chromium carbide (Cr_mC_n), thus depleting the adjacent area of chromium to the point where corrosion resistance is impaired. The carbide precipitates at the grain boundaries. This phenomenon is known as sensitization. Later exposure of the sensitized stainless steel to a strong corroding medium results in intergranular corrosion.

Carbon does not behave entirely as a malefactor in stainless steels since it does contribute significantly to the mechanical properties of the alloy. It is important to keep in mind, however, its part in sensitization.

Chromium—The basic agent for imparting corrosion resistance to stainless steels is chromium. It is present in austenitic alloys in the order of about 18 percent. Chromium's contribution to corrosion resistance apparently arises from its ability to form a microscopically thin layer of chromium oxide over the surface of the stainless steel. This impenetrable layer is inherently resistant to corrosive attack.

When broken by scratching or abrasion, it rapidly reforms under oxidizing conditions, thus affording fresh protection against corrosion.

Nickel—The protective qualities of the chromium oxide layer mentioned above are further enhanced by the addition of 8 percent or more nickel to the alloy. This addition provides corrosion resistance to a much greater variety of chemical con-

ditions than is exhibited by the straight chromium steels. Nickel changes the microstructure of the stainless steel to austenite which is non-magnetic and cannot be hardened by heat treatment. It contributes materially to better weldability, promotes ductility, permits work hardening.

Molybdenum—This element is used in Types 316 and 317 to augment corrosion resistance of the chromium nickel alloy to various reducing media. Among these are the sulphides, sulphates, phosphates, acetates and their respective acids (sulphurous, sulphuric, phosphoric and acetic) as well as the chlorides and fatty acids. While Types 316 (2 to 3 percent molybdenum) and 317 (3 to 4 percent molybdenum) resist attack by most corrodents better than the straight 18-8 types, they are inferior to those in corrosion resistance under certain strongly oxidizing conditions and in strong alkali service.

Columbium—The primary function of columbium in stainless steels is to thwart carbon in its efforts to impoverish grain boundaries of chromium. Since carbon has a greater affinity for columbium than for chromium, the stable compound, columbium carbide, forms preferentially during stabilizing heat treatment, thus immobilizing the carbon and preventing chromium depletion. Columbium is present in Type 347 stabilized stainless steels in amounts not less than 10 times the carbon content. Columbium also serves to preserve mechanical strength at elevated temperatures.

Titanium—Titanium plays the same role in stainless steel as columbium, in that it combines with the carbon forming a stable carbide, thereby preventing the reaction between carbon and chromium. Titanium is present in Type 321 stainless steel in amounts not less than five times the carbon.

Other Elements—There are other alloying agents present in stainless steel, either by intent or accident, but their contribution is less distinct than those above and they require nothing more than a mention here. They are silicon, copper, manganese, sulphur, phosphorus, tantalum and vanadium.

SENSITIZATION

As noted earlier, the presence of carbon in excess of 0.03 percent in 18-8 alloy renders the alloy susceptible to sensitization (carbide precipitation) upon heating within the range of 800 to 1,600 deg. F. for greater than 3 min. The mechanism of this reaction is generally believed to be the formation of chromium carbide, Cr_4C_n, which precipitates as a continuous envelope about the individual austenite grains. This results in the chromium impoverishment of the grain surfaces.

Upon exposure to a strong corroding medium the outer chromium-depleted shells of the austenite grains dissolve. Disintegration of the alloy thus occurs along intergranular paths with the unaffected cores of the austenite grains becoming detached.

The degree of carbide precipitation encountered in stainless steel is influenced by the temperature of exposure within the sensitization range, time of exposure, carbon content and alloy composition.

Below 800 deg. F., precipitation of the carbides is virtually non-existent. At 800 deg. F., precipitation takes place only with great reluctance and at about 1,000 deg. F., it occurs somewhat more rapidly. However, at 1,200 deg. F. this reaction is extremely accelerated. The rates of reaction at 1,400 and 1,600 deg. F. correspond approximately with those at 1,000 and 800 deg. F. respectively. Between 1,600 and 1,800 deg. F. no carbide precipitation occurs, while above 1,800 deg. F. the reaction is completely reversed with the chromium carbide dissociating itself into its components which re-enter the austenite grains as a solid solution, thus restoring the stainless steel to its original form.

As in most solid state reactions, time is required for the formation of chromium carbide and its precipitation at the grain boundaries. Because of the sluggishness of the reaction in the 800 to 1,000 deg. F. and 1,400 to 1,600 deg. F. ranges, exposure in these ranges of as long as 15 min. may prove relatively harmless to a 0.07 percent carbon 18-8 alloy. At 1,200 deg. F. however, such an exposure would result in a disastrous concentration of precipitated carbides for the same alloy. For these reasons it is generally recommended that quenching from heat treating temperature (above 1,800 deg. F.) to 800 deg. F., be accomplished within 3 min. to avoid a deleterious degree of carbide precipitation.

The carbon content of the alloy has, of course, a great influence on the degree of carbide precipitation under a given set of conditions. When the

Being coated here with a resin-based putty is the outside of a plating rinse tank.

Thick Resin Coating in One Step

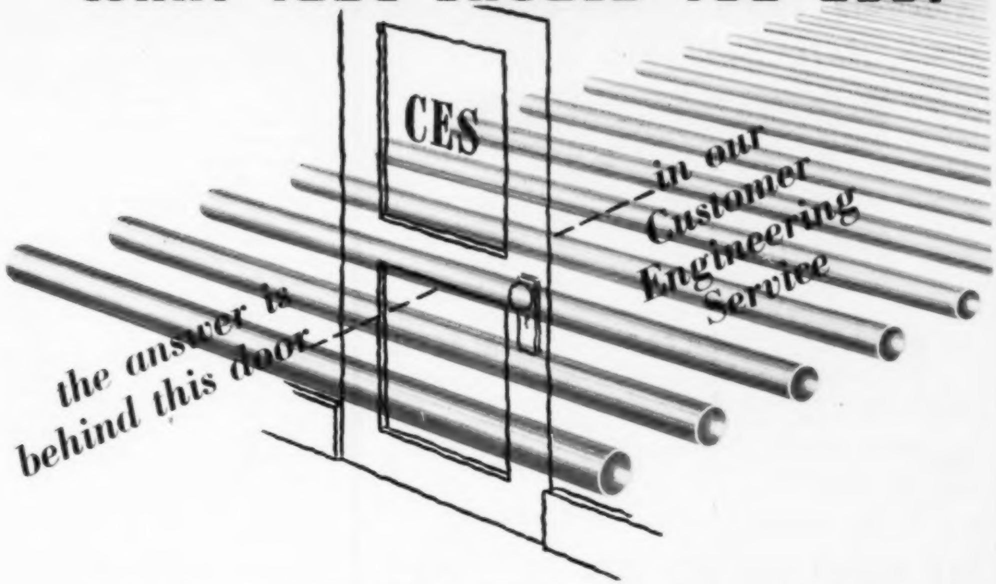
A putty made by adding a gelling agent to a polyvinyl chloride plastisol (dispersion of the resin in a plasticizer) eliminates need for several coats of paint or dipping to get extra thickness. Developed by Munray Products, Cleveland, it is based on Goodrich Chemical Co.'s Geon 121 vinyl resin.

Fusing the plastic putty coating is done either by oven baking or infra red lamps. It will reach a Durometer A hardness of 90-95. Because it contains no volatile materials, it can be applied safely, and there is no change in viscosity during storage.

Oddly-shaped equipment can be easily coated by hand with the putty exactly where the coating is needed most. Using costly special dip-coating equipment, plastic would be wasted on surfaces requiring no protection.

Extra thickness is sometimes desirable for better protection from corrosives, and superior protection against abrasion and rough handling.

WHAT TUBE SHOULD YOU USE?



A tube of a certain alloy will "take it" better than a tube of a different alloy.

And these days — when you are vitally interested in keeping your condensers operating at full efficiency as long as possible — you must be absolutely certain that the tubes in those condensers are most suitable for the material they must handle.

Be sure that they are made of the alloy that is most immune to the corrosive action of the liquid or gas the tubes will carry and therefore give you the longest uninterrupted service.

Whether it's a question of proper alloys — the best wall thickness of tube to use — or a question of the relative values of plain tube against finned tube — you'll find the answer here at Wolverine's Customer Engineering Service.

We suggest that you draw on the wealth of specialized experience that is here at your command without obligation.

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carbon content is held below 0.03 percent, there is relatively little carbon available to cause chromium depletion of the austenite grain surfaces. Furthermore, what carbides do participate are not sufficiently abundant to form a continuous envelope about the austenite grains. Progressive intergranular corrosion is thus inhibited.

The effect of alloy composition upon carbide precipitation can be illustrated by subjecting samples of 304 and 316 of identical carbon content to the same sensitizing heat treatment and comparing their appearance upon etching. The Type 316 specimens will show materially less intergranular corrosion than the 304. Molybdenum present in the 316 alloy, while not preventing the formation of chromium carbide, seems to promote its precipitation in isolated pools rather than as a continuous envelope at the grain boundaries. Molybdenum bearing 18-8 alloys are therefore less susceptible to intergranular corrosion, although not to a dependable extent.

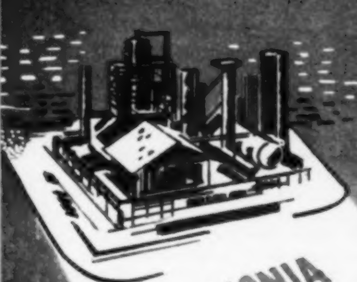
SOURCES OF CARBIDE PRECIPITATION

The most common source of carbide precipitation in the fabrication of 18-8 equipment is the heat of welding. During the welding operation, the weld bead is necessarily at a temperature greater than 2,650 deg. F. (melting point of the alloy) with the extremities of the weldment being at room temperature. A thermal gradient thus exists with a ribbon-like zone lying on either side of the weld being heated within the sensitization range. The heat sources of the cooling weld furnishes a thermal reservoir to keep this zone within the sensitization range for an appreciable length of time. Low heat conductivity of 18-8 (about half that of carbon steel) further aggravates this situation; the result is carbide precipitation and subsequent intergranular corrosion.

The heat affected zone lies from $\frac{1}{8}$ to $\frac{1}{4}$ in. from the edges of the weld bead and varies in width from $\frac{1}{8}$ to $\frac{3}{8}$ in., depending upon the gage of metal and method of welding.

The thickness of metal being joined exerts a great effect upon the degree of carbide precipitation. 16-gage material welded by a metallic arc process normally cools so rapidly in air that little or no sensitization results. With 12-gage material however, a distinct, though narrow, heat affected zone exists.

The various welding processes promote carbide precipitation to varying degrees. Resistance welds are generally employed only on lighter gages and are performed in the presence of water



IS CORROSION YOUR

HEADACHE?

AMMONIA
HYDROGEN SULFIDE
CHLORINE
SULFURIC ACID
ETHYLENE OXIDE
CO_2
HYDROFLUORIC ACID
CAUSTIC

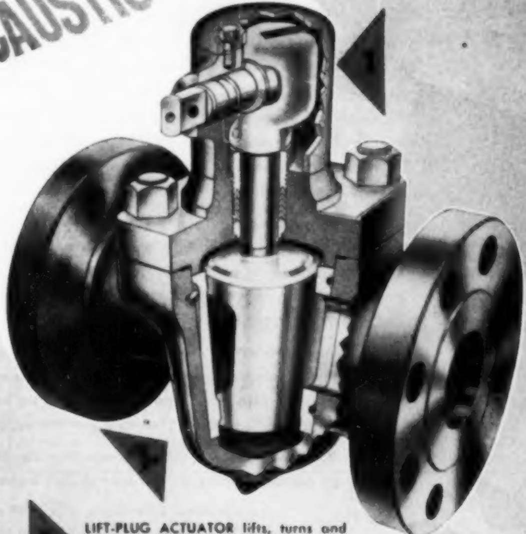
HERE'S A VALVE THAT WILL GIVE YOU RELIEF...

Cameron NON-LUBRICATED LIFT-PLUG VALVE

No matter what the service may be, here is a plug valve that is unique in that its seat is separate and not attached to the body and, therefore, can be trimmed in any desired corrosion-resistant alloy. Thus, the seat and plug may be replaced easily and at low cost, should it become necessary, by simply removing the bonnet. The entire operation requires only a few minutes and the valve body remains in the line. Here is, truly, an innovation in special trim valves for special services.

The Cameron Lift-Plug Valve is non-lubricated. Think of the man-hours (and grease) it will save you. This feature also prevents contamination of line products by valve lubricants. There's nothing to clog metering equipment, either.

Let us send you a booklet that tells the complete story of this remarkable valve. Like other plant operators who have purchased these valves for particularly difficult services, you may find them to be the answer to all of your problems, too. Please write to:



1 LIFT-PLUG ACTUATOR lifts, turns and reseats plug in only three-quarters of a turn of the operating wrench.

2 SEPARATE, RENEWABLE SEAT: Pressure-created body deflections and line strains cannot destroy the geometry of the fit between sealing surfaces because they cannot be transmitted to the separate seat.

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jets. This combination inhibits the formation of carbides. Inert gas shielded metallic arc welds (Heliarc) when backed with chill bars, show a relatively low order of sensitization. Next in order of increasing severity are submerged arc welds and hand arc welds which tend to induce approximately equivalent amounts of precipitated carbides. Oxyacetylene welds are much the worst offenders.

Specification of welding method is not commonly the prerogative of the purchaser of stainless steel equipment. He must rely upon the experience of the fabricator to select the optimum scheme for producing a given weldment.

Other sources of sensitization in the fabrication of 18-8 stainless steel are forging, hot forming, and flame or powder cutting.

EXTRA LOW CARBON GRADES

In an effort to solve the problems posed by sensitization during fabrication, a number of mills are presently producing special grades of 304 and 316 stainless steels with a maximum carbon content of 0.03 percent. These are designated as extra low carbon.

The basis for the selection of 0.03 percent carbon maximum can be seen since no measurable intergranular corrosion occurs below this point.

One should not infer that no carbide precipitation will occur in the extra low carbon stainless upon prolonged heating within the sensitization range. Recent data indicates that 0.03 percent carbon stainless steel will show evidence of carbide precipitation when heated to 1,200 deg. F. for periods as short as 1 min. However, the chromium carbides thus precipitated are apparently discontinuous, thereby minimizing the degree of intergranular corrosion upon exposure to a corrodent. Extra low carbon grades indicated as a substitute for 347 are cheaper, though not quite as effective.

STABILIZED STAINLESS STEELS

A successful method for prevention of carbide segregation and its related intergranular corrosion is the employment of stabilized stainless steels. Titanium or columbium, when added to 18-8 heats in sufficient amounts, combines with the carbon to form stable carbides uniformly dispersed in solid solution. The chromium thus remains free to perform its primary function of preventing corrosion resistance and no envelope of low corrosion resistant material forms around the austenite grains. Other stabilizing agents, principally tantalum and vanadium, behave similarly but they have certain

practical limitations as well as being uneconomic.

Since the metal columbium is widely used in high strength alloys and heat resistant alloys, its use as a stabilizing agent in stainless steels has in recent months has been drastically limited. A substitute material consisting of a columbium-tantalum alloy is now being used fairly extensively to promote stabilization in stainless steels. This too, however, is becoming increasingly difficult to obtain.

Titanium is present in Type 321 stainless steel in amounts not less than five times the carbon content. Columbium is the stabilizing agent in Types 347, 318 and 309Cb and its minimum content for effective stabilization is 10 times the carbon content. Tantalum, due to its higher atomic weight, is only about half as effective as columbium. Thus we might reasonably assume that tantalum would be required in amounts not less than 20 times the carbon content for effective stabilization.

Type 321 stainless steel is used extensively in Europe, while the columbium stabilized grades have traditionally been more popular in the U. S. Because of the difficulty mentioned above with respect to availability of columbium, type 321 is today, however, being more widely produced in this country.

There are a number of points of superiority of Type 347 over Type 321 which justify its selection for many services in spite of its slightly higher cost per pound.

Titanium combines much more avidly with oxygen than does columbium and is therefore more easily lost during welding. For this reason Type 347 wire is almost invariably used for all weld deposits in Type 321 stainless steel. At elevated service temperatures, columbium carbide appears to be more stable than its titanium counterpart. Type 347, furthermore, is distinctly superior to 321 under strongly oxidizing conditions, although there is some evidence to indicate that type 321 has the greater resistance to sulphates and sulphuric acid. In certain specific services, such as fuming nitric acid, Type 347 is more resistant to attack than the generally superior alloy Type 316. This is also true in strong alkali service.

A stabilized molybdenum bearing stainless steel is currently under investigation by a number of authorities and may ultimately prove of benefit in suppressing carbide precipitation in the 316 family of stainless steels. This has variously been designated as Type 316 Cb or Type 318. Certain metallurgical difficulties have arisen however, and its application is still extremely limited.

(Continued)

In the case of all stabilized types of stainless steels, the carbon content is generally held to 0.08 percent max. This reduces the amounts of titanium and columbium which must be used to fix the carbon thus effecting conservation of these metals. Any undesirable characteristics that might arise from excessive use of titanium or columbium are similarly minimized.

HEAT TREATMENT

Of the three commonly used methods for prevention of intergranular corrosion in stainless steel, two have been covered in preceding sections; that of holding carbon to a minimum content and that of locking up the carbon with a stabilizing agent. The third and most reliable is heat treatment.

These are the three basic premises upon which the theory of heat treatment is based: (1) carbides are present in weldments, (2) they can be dissolved by heating above the sensitization range, and (3) their recurrence can be prevented by rapid cooling through the sensitization range.

The procedure of full annealing takes account of these three elements. It consists of rapidly heating the work to about 1,950 deg. F. to dissociate the carbides; holding for a short time at 1,950 deg. F. to insure uniformity of temperature within the work and to permit the resolution of the carbon and chromium; quenching rapidly in water to "freeze" the carbon and chromium in solution and prevent their reforming chromium carbide. The rapid quench may be defined as cooling from 1,950 to 800 deg. F. within 3 min.

It is important that holding time at 1,950 deg. F. be not longer than is necessary to assure thermal uniformity. Excessive holding at this temperature promotes undesirable grain growth with resulting loss of ductility.

In addition to eliminating carbide precipitation this heat treatment softens the material for subsequent fabrication and, in the case of completed vessels, nullifies welding and forming stresses.

The ASME Boiler Code recognizes the importance of heat treatment in its interpretation of special Case #897. Here it specifically states that all stainless steel U-69 pressure vessels whose wall thickness exceeds ½ in. and all stainless steel U-68 vessels, irrespective of wall thickness, must be heat treated by one of three methods. It further states that heat-treatment is desirable, though not mandatory, for other pressure vessels.

Of the three code-sanctioned heat treating methods, the one described

above, full anneal, is applicable to all of the four major types of austenitic stainless steel, 304, 316, 321 and 347. It is the only one acceptable for Type 304.

An alternate method of heat treatment, stabilizing anneal, may be used for 321 or 347. This alternate consists of heating the completed vessel to 1,600 deg. F., holding for a period based on 2 hr. per in. of thickness (but in any case not less than 2 hr.) and cooling in still air or in the furnace. Since 321 and 347 are stabilized, no undesirable carbide precipitation occurs under these conditions. The purpose of it is to relieve welding and forming stresses and to promote the reaction of the columbium in the weld with the carbon thus stabilizing the weld.

Type 316 only may be heat treated by the third method of heat treatment recognized by the code. This method is to heat the 316 vessel to 1,625 deg. F., hold for about 72 hr. and cool in still atmosphere. This too, relieves all forming stresses but results in inferior corrosion resistance. Because of this latter point and the obviously exorbitant costs involved, it is rarely used.

ADVANTAGES OF HEAT TREATMENT

While the extra low carbon grades and the stabilized grades of stainless steels are making valuable contributions toward the application of these alloys under corrosive service certain advantages of heat treatment must be stressed.

The ASME Boiler Code Committee has recently approved the use of extra low carbon grades of 304, 316 and 317 for pressure vessels in the Special Case #1122. However, the corresponding heat treated standard grades have significantly higher allowable stresses. Thus, for a given pressure, greater wall thicknesses must be used when designing for extra low carbon types than for heat treated standard types.

The use of either the extra low carbon grades or the stabilized grades does not abolish the requirements for stress relief heat treatment when designing to code paragraph U-68 or U-69. Indeed, under any circumstances where stress corrosion might be a factor annealing of the completed weldment is desirable.

Somewhat more dependable freedom from carbide precipitation is achieved by full anealing after fabrication than by reliance upon as-welded extra low carbon material.

Due to the relative unavailability of columbium as a stabilizing agent, the straight 18-8 grades are more easily obtainable. —End

WELDING LABORATORY—Center of research covering electrodes, procedures, processes, and equipment. Special equipment is available to determine the best procedures for shop and field welding. Extensive tests are made to adapt new procedures to automatic, as well as manual application.

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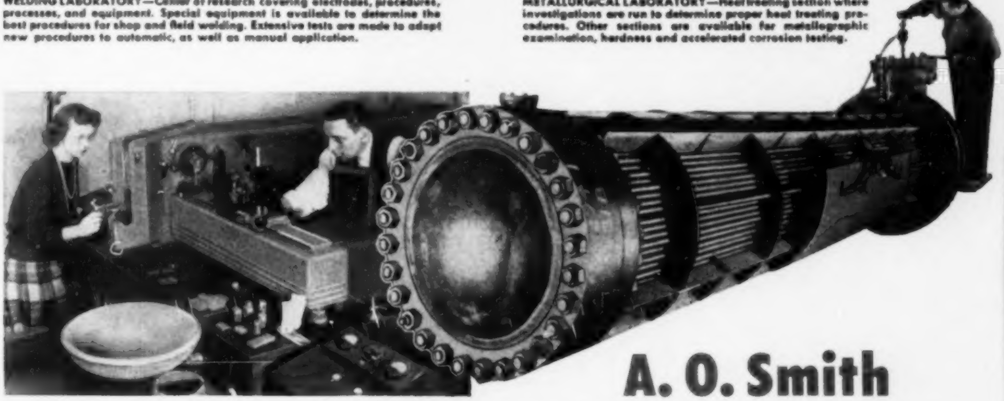

SPECTROGRAPHIC and X-ray diffraction equipment is used for exacting analysis of materials and manufacturing processes. They are also used in special investigations relating to heat exchanger research projects.

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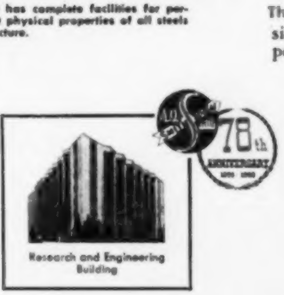
INDUSTRY COMES TO A.O.SMITH WITH HEAT EXCHANGER PROBLEMS



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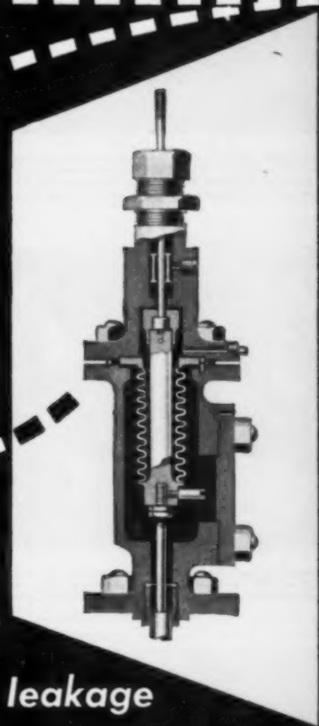

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EGYPT—This large Suez project will eventually produce 200,000 tons of calcium nitrate annually from limestone and nitric acid. The intermediate product, ammonia, is manufactured from the ***waste gas of a nearby petroleum refinery.***

INDIA—This large plant at Sindri is designed to produce 350,000 tons of ammonium sulfate per year. Major raw materials are ***coal, coke and gypsum***—all indigenous to India.

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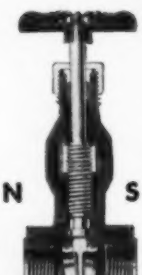

Fig. 1640
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You and Your Job **Edited by Richard V. Reeves**

Photo courtesy Standard Oil Co. (N. J.)

Is Supervision or a Free Hand Best for Research Personnel?

A recent study strongly hints that the researcher who bosses himself contributes the most to his company. Do you agree? If you do, here's evidence to back you up.

Does your company get the most out of its research personnel? If it doesn't, perhaps it could by providing the climate that attracts and nurtures creative effort.

But how do you define this optimum environment in which the creative scientist flourishes?

Research supervisors have wrestled with this and similar question for many years. More than a few have found the human element in research a darned important—though nebulous—variable.

Recently, Dr. Raymond Van Zelst, a psychologist at the Illinois Institute of Technology and Willard A. Kerr thought it would be a good idea to study the work habits of the 467 scientific and technical personnel at Armour Research Foundation and the Illinois Institute of Technology. This group made up a good sample of research personnel and research problems, both fundamental and applied. The 337 research projects that engaged them, ranged from basic studies of the element silicon to high-pressure sterilization.

Drs. Van Zelst and Kerr received answers to 194 questionnaires from 47 percent of the 467 research personnel and faculty members engaged in research activities at the institution.

Besides the usual question about age and professional rank, the psychologists asked essentially: How hard do you work (a) at the office, classroom or laboratory; (b) at home? How much have you accomplished in your research? Under what conditions do you like best to work?

Along with the answers to the questions, the scientists got a pretty good picture of the average man engaged in research at Technology Center. For every man with a bachelor's degree, three possess a doctorate and two have earned a master's degree. The average researcher is about 35, a member of four or more societies, a reader of more than five technical and scientific journals. He works 43-44 hours a week at his workplace and three to four more hours each day at home.

Under what conditions does a technical man work best? First the psychologists asked about incentives, economic and humanitarian. Eight percent of the respondents said they were stimulated to do their best work when their organization stood to make money. Nineteen percent said they worked best when they, themselves, stood to profit financially. But the greatest majority—73 percent—were motivated by the desire to accomplish something they considered "good."

Asked, next, about supervision, the majority of respondents—62 percent—preferred to have one person initiating and carrying on research with complete freedom to select assistants. Fourteen percent liked to have one person initiating a project and the group sharing equally in the execution of the work. The remainder—24 percent—suggested that any member begin an investigation, but the group carry on the work and each member share according to the value of his contribution.

Do you prefer to have a deadline for your work, was the next question.

Twenty-six percent wanted no specific deadlines. The remainder were asked if they preferred a deadline set by their supervisor or themselves. More than half—51 percent—preferred their own deadlines. The remaining 23 percent said that they would rather let their supervisor assume this responsibility.

In the category of productivity, the psychologists counted up the number of patents and publications of each researcher giving publications the same weight as patents. The average was 2.3 patents per man and 10.5 publications.

Trying to correlate their findings by balancing productivity against work habits and preferences, the psychologists generalized as follows.

Within the limits of the study, Drs. Van Zelst and Kerr found that the men who produced the most had earned more academic degrees, read more journals, belonged to more societies, put less emphasis on equality among associates, liked to set their own deadlines for their projects and were motivated more by altruistic goals. The study also suggested that maximum productivity was achieved with (a) 28 hours per week of regimented work and (b) 3.5 hours per day of related homework. While this doesn't advocate a 28 hour work week, certainly, no one will question the wisdom of keeping creative workers as free as possible of routine and rigid assignments.

The editor thanks Dr. Van Zelst for making available the results of his study which were published in the *Journal of Abnormal and Social Psychology*, Oct. 1951, p. 470; and for supplying further statistical results of the study which will be published in the March issue of the Journal.

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CONDENSER AND HEAT EXCHANGER TUBE EDITION

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ALUMINUM BRASS GIVES GOOD SERVICE
Under Severe Operating Conditions

Continuous operation associated with higher operating efficiency is putting a heavier burden on condenser and heat exchanger tubes. Alloys which gave a good account of themselves in former years when equipment was operated intermittently well within design velocities, are failing under the grueling effect of constant operation.

It is well known that petroleum refinery units are kept going 'round the clock month after month until breakdown of individual pieces of equipment makes it more practical to shutdown the unit for major overhauling. Likewise in the power generating field, the accelerated demand for power in the last decade has in many cases not only utilized standby equipment going at full schedules but has often called for power output beyond design capacity.

This explains why alloys such as Admiralty, which gave such excellent performance in former years in certain condenser installations, often fail prematurely when used for retubing under present severe operating conditions.

On the other hand, such alloys as aluminum brass (78% copper, 2% aluminum and 0.03% arsenic, balance zinc) have been growing in importance and are replacing Admiralty in many installations. Aluminum brass is inherently more resistant to corrosion than Admiralty from both slow and rapidly moving sea water as well as polluted waters in harbors and rivers that are contaminated by sewage and industrial wastes. Aluminum brass, when replacing Admiralty, generally gives a better account of itself particularly where inlet-end corrosion or impingement corrosion has been a serious problem.

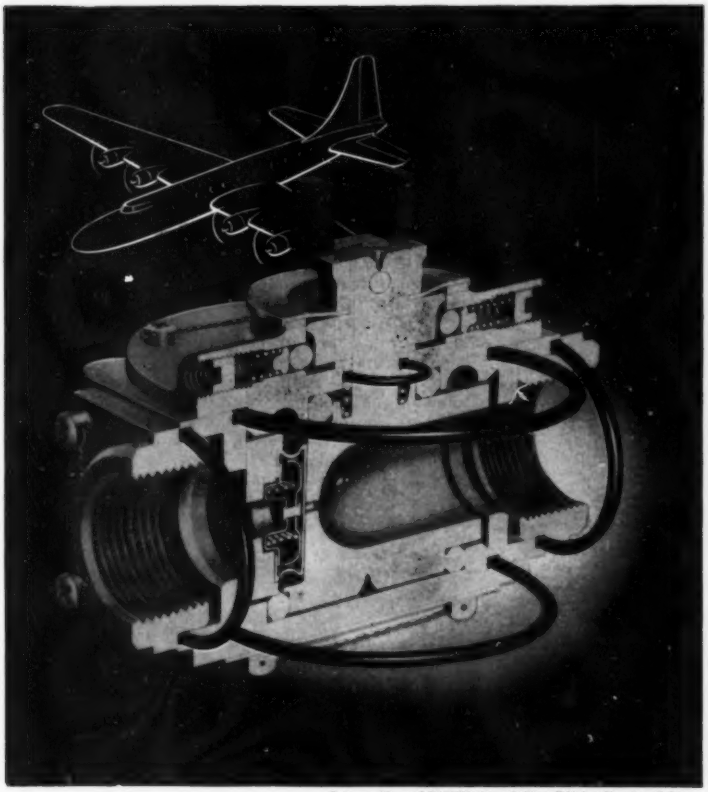
It has also been found that higher velocities of circulating water, either fresh or salt, are prone to attack Admiralty more severely than aluminum brass. It must be borne in mind that it is necessary to use arsenic as an inhibitor of dezincification in aluminum brass as well as in Admiralty to assure longer service life.

In common with Admiralty, aluminum brass has good corrosion resistance to sulphur compounds found in various petroleum liquids and gases.

The table giving comparative physical and mechanical properties of arsenical aluminum brass versus arsenical Admiralty should be helpful to design engineers. (8022)

COMPARATIVE PHYSICAL AND MECHANICAL PROPERTIES OF ARSENICAL ALUMINUM BRASS AND ARSENICAL ADMIRALTY

ANALYSIS	Aluminum Brass 54	Arsenical Admiralty 30
Copper	77.0	71.0
Tin		1.05
Aluminum	2.1	
Arsenic	0.03	0.03
Zinc	balance	balance
MECHANICAL PROPERTIES		
Tensile Strength—Soft	50,000	45,000
Yield Strength—Soft	18,000	15,000
Elongation % in 2" Soft	55	65
Contraction in Area % Soft	72	71
Rockwell Hardness—Soft	F77	F75
Elastic Limit—Soft	16,000	18,000
Modulus of Elasticity in Tension x 10^6	16	16
PHYSICAL CONSTANTS		
Density @ 68°F lbs./cu. in.	.301	.308
Specific Gravity	8.33	8.53
Melting Pt. °F Liquidus	1780	1720
Solidus	1710	1650
THERMAL CONSTANTS		
Coefficients of Thermal Exp. per °F from 68°F to 572°F x 10^{-6}	10.3	11.2
per °C from 20°C to 300°C x 10^{-6}	18.5	20.2
Thermal Conductivity at 68°F BTU/sq. ft./ft./hr./°F	58	64
Calories/cm²/cm/sec/°C	0.24	0.26
Thermal Capacity (spec. heat) @ 68°F BTU/lb./°F	.09	.09
@ 20°C cal./gm./°C	.09	.09
ELECTRICAL CONSTANTS		
Resistivity ohms/mil foot @ 68°F (annealed)	45	42
Conductivity % IACS @ 68°F (annealed)	23	25
(annealed) megmho-cm³ @ 20°C	0.133	0.145
Resistivity, micro-ohm centimeters @ 20°C (annealed)	7.5	6.9
Color	Yellow	Yellow
FABRICATION PROPERTIES		
Cold working	Excellent	Excellent
Hot working	Fair	Fair
Hot working Temp. °F	1400-1600	1200-1450
Hot Working Temp. °C	750-875	650-800
Machinability rating	30	30
Soft soldering	Good	Excellent
Silver brazing	Good	Good
Oxyacetylene welding	Good	Good
Carbon arc welding	Good	Fair
Resistance welding	Good	Fair
Polishing	Good	Good
Annealing Temp. °F	800-1100	800-1100
SPECIFICATIONS		
A.S.T.M	B-111-50	B-111-50
U. S. Navy		44T7g
Federal		WW-T-756a



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Names in the News Edited by Frances Arne

MAN OF THE MONTH: Ralph M. Hunter

President of the Electrochemical Society as it celebrates its Golden Anniversary is manager of Dow's electrochemical division.

Ralph Hunter himself has been in the electrochemical field, with Dow, since 1918. He has had charge of production and development of the Dow chlorine cell, magnesium, graphite electrode and synthetic ammonia processes. In addition to his pose with Dow proper in Midland, he is a director of Dow Chemical of Canada, Ltd., and a director and president of the Midland Ammonia Co.

He sums up his approach to his work with this advice. "Never do a job by electrochemistry if you can do it by conventional chemistry—but you will find that electrochemistry, when required, is often the only way to do many of the industry's most difficult jobs." Some of the difficult jobs credited to Hunter are important improvements in the electrolytic production of magnesium, chlorine, caustic soda, liquefaction of chlorine, ammonia and bromate.

He gets fun out of tackling complex jobs. His tremendous capacity for work easily overflows into professional societies, civic and social affairs. As he puts it, "People ask me to do things and I'm just one of those guys who can't say no." In addition to the Electrochemical Society, a sampling of the organizations in which he takes an active part: ACS, AIChE, National Association of Corrosion Engineers, Chlorine Institute, Kiwanis, the Masons. An alumnus of Case Institute, he's currently a member of its board of trustees.

His son Hilton started him on his pet hobby, sailing. For the past 12 years he's devoted his summer week ends to it. Now he's a Commodore in Michigan's Torch Lake Yacht Club.

And he claims to have some spare time left over. In summer he spends it in his backyard in Midland, gardening when the spirit moves him.

Louis Koenig. Associate director of Southwest Research Institute. Formerly with Stanford Research Institute as assistant director of research in charge of all activities in chemistry, chemical engineering, air pollution, metallurgy, ceramics, food technology and applied biology. Before that, chairman of chemistry and chemical engineering at Armour Research Foundation.

James I. Hoffman. Assistant chief of the National Bureau of Standards' chemistry division. Has been chief of the surface chemistry section. Joined the bureau as a chemist in 1919. Recipient of the Hillebrand Prize in 1946 for significant contribution for chemical science.

Fred J. Emmerich. Recipient of the 1952 Gold Medal of the American Institute of Chemists. President of Allied Chemical & Dye Corp. With the organization since 1920.

N. Irving Sax. New member of the analytical branch of the health and safety division of AEC's New York operations office. Formerly head of the special problems group of the chemical section of GE's Schenectady Works laboratory. Graduate of Rensselaer Polytech.

James G. Knudsen. From assistant to associate professor of chemical engineering at Oregon State College. Doctorate from the University of Michigan.

Roy A. Campbell. Chief chemist, British American Oil Co. Ltd. Since 1949, technical assistant in the marketing department. Joined B-A in 1931 as resident chemist at Toronto refinery.

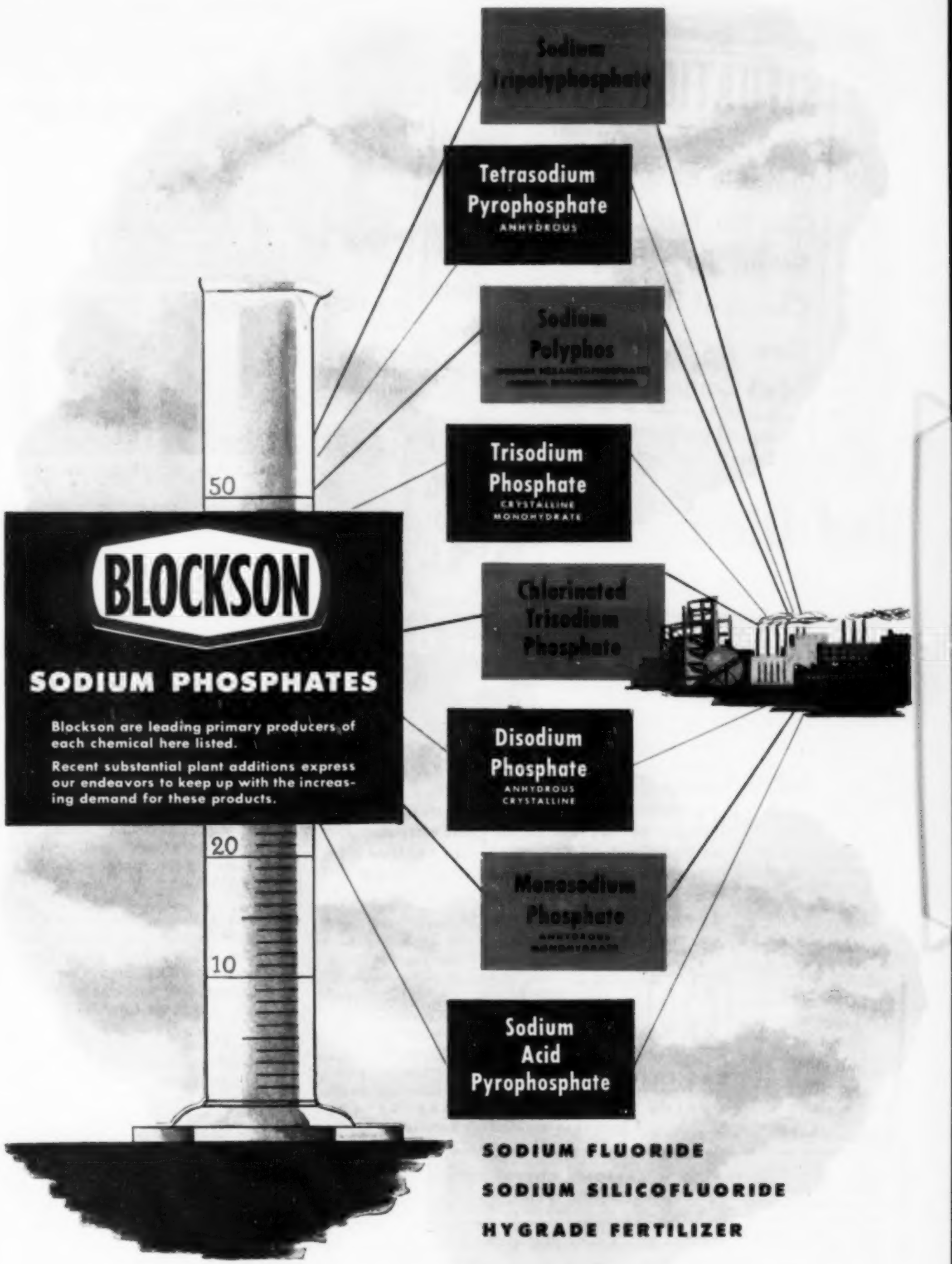
Robert E. Wilson. Chairman of the committee on research, NAM, for a second year. Chairman of the board, Standard Oil (Indiana). Vice chairman of the NAM committee: **R. G. Follis,** chairman of the board, Standard Oil of California; **Randolph T. Major,** vice president and scientific director, Merck.

Abram Davis. Research chemist, Hooker: **Thomas Hooker.** Previ- ied at Lake Forest College and Illinois Institute of Technology. New chemical engineer with Hooker: **Thomas Hooker.** Previous employers: Pfaudler, Distillation Products Industry. Studied at the University of Rochester and MIT.

Paul T. W. Strub. Manager of commercial development with Great Lakes Carbon Corp.'s engineering and development department. For the past five years with the butadiene and styrene section of the synthetic rubber division of RFC. Before that, with the technical service group, chemical products division, Esso Standard Oil.

Frederick G. Keyes. Treasurer, Alfred Bicknell Associates, Cambridge, Mass. Continues in his two-year-old post as director of research. Retired chairman of the chemistry department, MIT. New vice president of the company: **Arthur B. Lamb,** retired chairman of Harvard's chemistry department.

William P. Drake. Director of the Rubber, Chemicals and Drug Division, OPS. Vice president in charge of sales, Pennsalt, since 1949. Started with the company in 1934.



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M. L. Haider. Deputy coordinator of the worldwide oil producing activities for Standard Oil (New Jersey). Since 1946, general manager of Imperial Oil Ltd's producing department. Chemical engineering graduate of Stanford.

George O. Curme, Jr. Director of Union Carbide and Carbon Corp. Continues as vice president in charge of all research activities. Pioneer in the petrochemicals field.


G. O. Curme, Jr.


B. B. Turner

B. Bynum Turner. New member, board of directors, Ethyl Corp. Continues as vice-president in charge of research and engineering. Joined Ethyl in 1946. Previously with Rubber Reserve Co. then Humble Oil and Refining Co. Graduate of Rice Institute.

R. E. Irwin. Manager of the petrochemical plant of the newly-organized B. A.-Shawinigan Ltd. in Montreal East. Since 1945, chief chemist of the British American Oil Co. Ltd., Toronto.

T. W. Hauff. Manager-process in GE's manufacturing department at Hanford Works, Richland, Wash. Has been in the technical section of the engineering department at the Hanford Works.

William B. Brown. Manager of General Mills' chemical plant at Kankakee, Ill. Formerly plant manager of the Pittsburgh Coke and Chemical Co.; with the firm since 1942. Doctorate from NYU.

Morris Fidelman. New member of the staff of Paul W. Garbo, New York consultant in chemical and patent matters. Formerly with the government Patent Office.

Jack C. Dart. Manager of research and development, Houdry Process Corp. Director of the development laboratory since 1947. Previous employers: Standard Oil Development, Magnolia Petroleum Co., Pan American Refining Corp., Universal Oil Products Co. New asso-

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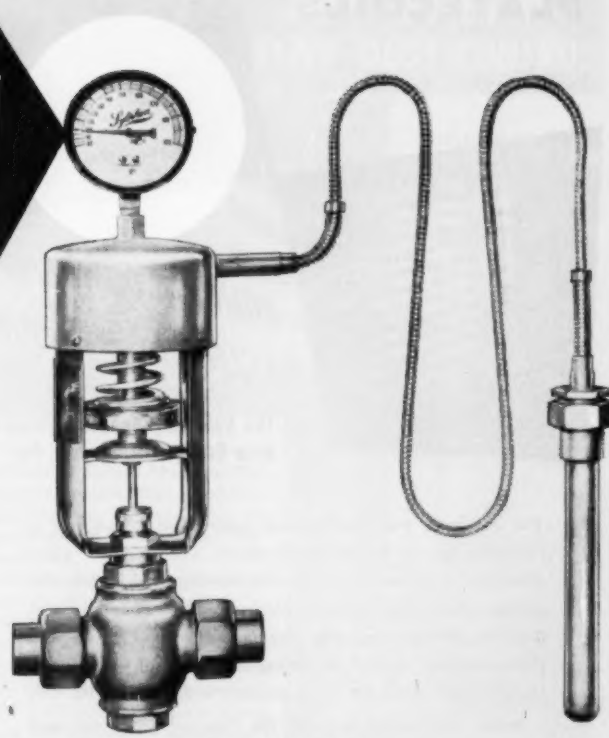

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ciate manager: **Alex G. Oblad.** With Houdry since 1947. Previous research posts with Standard Oil (Indiana), Magnolia Petroleum, Texas State Research Foundation. From assistant director to director of research: **G. Alexander Mills.** Previously, a member of Dartmouth's department of chemistry. From chief of the economics section, research and development department, to director of development: **Theodore A. Burtis.**

Carl Pacifico. Director of the development department, Wyandotte Chemicals Corp. He has been a member of the company's field service staff. Previous employers: Calvert Distilling Co., Publicker Industries Inc.

C. Pacifico

R. E. Vivian

Robert E. Vivian. Chemical production specialist, U. S. Mutual Security Agency, special mission for economic cooperation to Italy. On leave from his post as dean of engineering, University of Southern California.

Harold E. Graves. Chief chemical engineer with Jackson and Church Co. at Saginaw, Mich. Formerly professor and head of the department of chemical engineering, University of Rhode Island.

C. D. McCleary. From manager of process development to manager of basic research, Naugatuck Chemical Division, U. S. Rubber Co. His successor: **J. N. Judy,** formerly manager of technical service laboratories.

George W. Swenson and **Hubert J. Tierney.** Vice presidents, Minnesota Mining & Mfg. Co. Mr. Swenson began working for 3M as a research chemist in 1928. Mr. Tierney, with the company since 1927, will head manufacturing and product research and development for the company's new tape group coordinating operations of the firm's cellophane, industrial, masking, gummed paper, electrical and sound

recording tape divisions. Since 1949, manufacturing manager heading tape manufacturing and research.

M. D. Banus

R. W. Bragdon

M. Douglas Banus. Associate director of research in charge of the chemical research laboratories, Metal Hydrides, Inc., Beverly, Mass. Doctorate in chemistry from MIT. New assistant director of research: **Robert W. Bragdon.** With the company since the founding of the research laboratory in 1947. New member of the engineering staff: **Bernard A. Gruber,** formerly at Battelle's division of nonferrous metallurgy.

Wesley D. Schroeder. Supervisor, plasticizer research in the plasticizer division of the Pittsburgh Coke and Chemical Co. Formerly with Dow Chemical, GE, and lastly, Rohm & Haas. Doctorate in organic chemistry from the University of Kansas.

Robert Simha. Adjunct professor of chemical engineering, NYU. Professor at Howard University 1942 to 1945, following which he was a consultant for the National Bureau of Standards.

W. H. Congleton. With American Research and Development Corp., Boston. Previously with the research department of Standard Oil (Indiana). Studied at Princeton and Harvard.

Robert T. Haslam. Member of the board of directors, Dewey and Almy Chemical Co., Cambridge, Mass. Former vice president and director of Standard Oil (N.J.). Currently: President of U. S. Pipe Line Co., director of W. R. Grace & Co., director and member of the executive committee of Ethyl Corp., director of American Gas & Electric Co. and Worthington Pump and Machinery Corp. Prior to joining Standard Oil in 1927, professor of chemical engineering at MIT.

Alex M. Henricks. From service engineer in the Boston office to service

engineer headquarters staff, Hall Laboratories, Pittsburgh, Pa. From 1939 to 1940, supervised the Hall control laboratory. Chemical engineering graduate of the University of Pittsburgh. His successor in Boston: **Edward S. Stewart.**

George Karnofsky. Assistant to the director of research, Blaw-Knox Co.'s chemical plants division. Joined Blaw-Knox in 1943; active on the research staff of the fabricating division. Inventor of the Rotocel Extractor. Chemical engineering graduate of Purdue.


G. Karnofsky


J. C. Siegesmund

John C. Siegesmund. Vice president, engineering, Eli Lilly and Co. Joined the company at the beginning of his working career in 1919. Director of the engineering division, 1944 to 1951; since then, executive director of the function. Purdue graduate.

John F. White. Superintendent of Monsanto's Everett, Mass., plant. Joined the company's research department in 1928.

William E. Knappman. Technical director, United Lacquer Mfg. Corp. Has been chief chemist of Reichhold Chemical Co.'s eastern resin division sales service laboratories for four years. For ten years previous, with General Chemical Co.

Albert E. Forster. Vice president and member of Hercules Powder Co.'s executive committee. For the past eleven years, general manager of the naval stores department. Elected to the board of directors in 1941. With the company since 1925. New general manager of naval stores: **Paul Mayfield,** formerly assistant general manager. Joined the company in 1925 as a chemist.

Irl C. Schoonover. Assistant chief of the organic and fibrous materials division, National Bureau of Standards. Since 1935 with the bureau's dental materials section, most recently as head of it.

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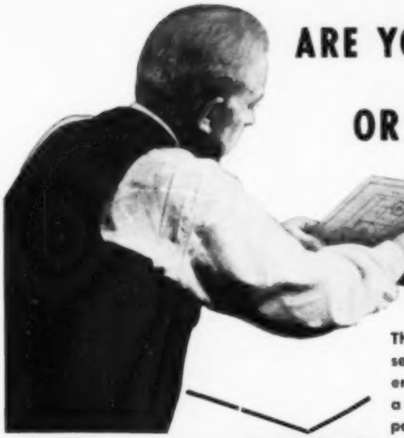

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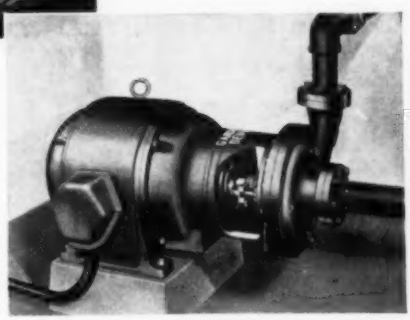

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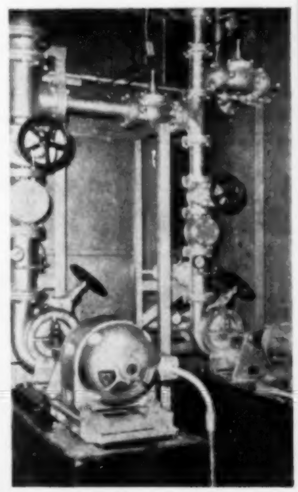

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NAMES IN THE NEWS, cont. . .

George O. Lines. General manager, Commercial Solvents' new animal nutrition division. Has been manager of the company's Peoria plant since 1946. Chemistry graduate of Iowa Wesleyan College.

William L. Rodich. From assistant general manager to general manager, laminated and insulating products department, GE's chemical division. With the company since 1950. Former employers: S. B. Penick and Co. Merck, Winthrop Chemical. Graduate of Brooklyn Polytech.

W. L. Rodich

B. Andersen

Bjorn Andersen. Technical director, Celanese. A company vice president, he has been director of the central research laboratories for the last four years. New associate research directors at the company's Summit, N. J. works: **B. B. Allen** and **R. T. Armstrong.** New coordinator of technical control in New York: **H. J. Philipp.**

Bradley Dewey. Director, W. R. Grace & Co. President of Dewey and Almy Chemical Co. which he organized in 1919. During World War II he was the country's rubber director.

G. R. Cuthbertson. Assistant factory manager of U. S. Rubber's Los Angeles plant. Started with the company as a research chemist in 1937.

Edward J. Johnson. Staff assistant to the superintendent of chemical services at Ethyl Corp.'s research laboratories in Detroit. Formerly head of the laboratories' chemical engineering section. Joined Ethyl in 1936. Graduate of Tri-State College. His successor in the chemical engineering section: **Theodore Carron,** with the company since 1946. Formerly a production engineer for Du Pont.

John O. Pritchard. Head of the new process evaluation division of the research department of American Potash & Chemical Corp. From 1941 to 1952, with the engineering

department of Du Pont. University of Wisconsin graduate.

William B. Baker. Director of product development, Armour Laboratories. Previous employers: Calco Chemical Division, Laboratories Uribe Angel, E. R. Squibb.

Philip J. Elving. Professor of chemistry, University of Michigan. Previously a Du Pont visiting lecturer in chemistry at Harvard.

Robert H. Helle. Technical superintendent to direct process control and development of the Chemstrand Corp.'s Decatur, Ala., plant. Has been supervisor of the company's Marcus Hook, Pa., pilot plant. Formerly a member of American Viscose Corp.'s research department. Studied at Oberlin College, Fenn College and the University of Rochester.

B. E. Thomas. Director of foreign manufacture for Monsanto's organic chemicals division. Has been a production manager of the division since 1943. Joined Monsanto in 1917. Now division production manager: **Paul G. Marsh,** who has shared the post with Mr. Thomas since 1949. A Monsanto employee since 1923. Assistant production manager: **John R. Durland,** formerly manager of the division's plant at Nitro, W. Va. His successor at Nitro: **James H. Zwemer,** formerly in charge of the chlorine plant the company is building for the Chemical Warfare Service at Muscle Shoals, Ala.

Lawton A. Burrows. General technical director of Du Pont's textile fibers department. Has been manager of the technical division of the explosives department. From assistant director to director, nylon research: **Chiles E. Sparks.**

Wallace B. Mathews. Coordinator of engineering and engineering research. Formerly assistant chief engineer in the general office. Joined Standard in 1923. New head engineer, manufacturing engineering department: **Robert R. Penman.** Formerly head engineer of the engineering department at Whiting, Ind. New assistant chief engineers of the manufacturing engineering department: **Wilbur G. Guild** and **Ben Franklin.**

Erwin G. Somogyi. Director of research for Monsanto Chemical Co.'s Merrimac Division. Since 1950, associate research director of

the company's plastics division. Joined the staff of Monsanto's control laboratory of the organic chemical division, St. Louis, in 1935; group leader in the research department, 1937; assistant research director, 1948.

Elwyn A. Holtgrewe. From assistant superintendent to superintendent of Victor Chemical Works' plant at Tarpon Springs, Fla. Started with Victor in 1939 in the engineering department, Nashville, Tenn., plant. Graduate of Iowa State.


E. A. Holtgrewe

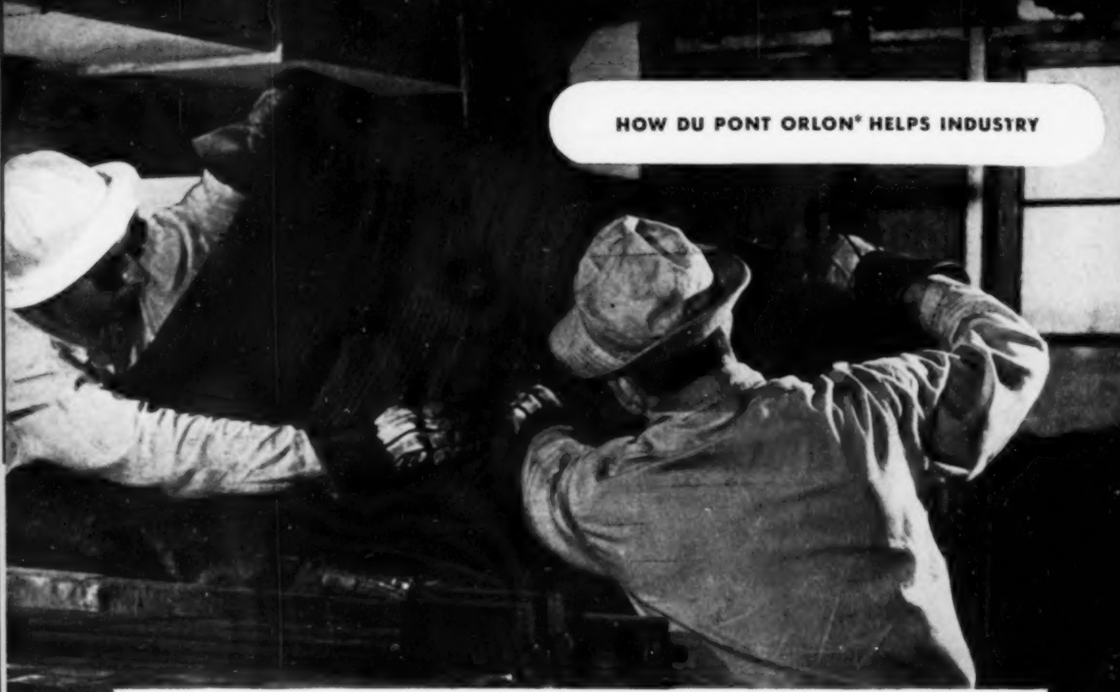

K. E. Rumbel

Keith E. Rumbel. New member of the staff of chemical engineers at Atlantic Research Corp., Alexandria, Va. Previously assistant professor at MIT and director of its school of chemical engineering practice, Buffalo Station.

Charles H. Hofrichter, Jr. Research section chief, research and development department, Olin cellophane division, Olin Industries, Inc. Formerly, Du Pont research chemist in the fields of cellophane and new films development. Studied at Hiram College, University of Buffalo (Ph.D.), Northwestern. New chief, engineering section: **Michael Karelitz.** Previous employers: Perkin-Elmer Corp. and General Precision Laboratories. Studied at Cal Tech and the University of Pittsburgh.

Mary L. Alexander. Chairman of the committee on nomenclature of the ACS division of organic chemistry. Assistant to the director of research, Universal Oil Products Co. University of Iowa graduate.

Harrison S. Brown. Recipient of the ACS Award in Pure Chemistry. Professor of geochemistry in the California Institute of Technology. From 1946 to 1951, assistant professor then associate professor at the Institute for Nuclear Studies and the department of chemistry in the University of Chicago.


HOW DU PONT ORLON* HELPS INDUSTRY

INDUSTRIAL NOTES

NEW LOCATIONS

B. F. Goodrich Chemical Co. has moved its sales offices on the Pacific Coast to 714 West Olympic Blvd., Los Angeles.

Chemo Puro Mfg. Corp. has moved its executive offices to Queens Blvd. and North 32nd Pl., Long Island City, N. Y.

Hewitt-Robbins Inc. moves its headquarters offices from New York to Stamford, Conn., early in April.

Kennecott Copper Corp. has moved its executive offices in New York to 161 East 42nd St.

Martin Dennis Co., manufacturer of leather-tanning chemicals, has consolidated its Newark and Kearny, N. J., plants at Kearny.

Petro-Chem Development Co., engineers and designers of processing furnaces for the petroleum, chemical and allied industries, has moved its headquarters to 122 East 42nd St., New York.

NEW REPRESENTATIVES

Sauereisen Cements Co., Pittsburgh, Pa., manufacturer of technical and industrial cements and bonding compounds, has appointed Montgomery Bros. as its exclusive West Coast distributors. Montgomery maintains offices and warehouses in San Francisco and Los Angeles, Portland, Ore., and Seattle, Wash.

Ampco Metal, Inc., Milwaukee, has appointed Upton, Bradeen and James Ltd. of Canada as an exclusive distributor of resistance welding tips, dies, holders, rods, bushings and wheels.

Fenwal Inc., Ashland, Mass., has appointed J. C. McDougall Co., Seattle, as its sales representative in most of the state of Washington.

American Metallic Chemicals Corp., Portland, Ore., has appointed Caldwell Chemical Co., New York, as its exclusive sales representative.

Godfrey L. Cabot, Inc., Boston, has appointed Henry L. Grund Co., Cleveland, as exclusive agents for the sale of Cabot carbon blacks to the paint, ink, plastics and related industries in the northern Ohio area.

Cleaver-Brooks Co., Milwaukee, has appointed the V. N. Harwood Co., Buffalo, N. Y., as representative for the sale of its boiler equipment.

Hercules Powder Co.'s cellulose products department has appointed Harrisons & Crosfield (Canada) Ltd. its distributors in Canada, except British Columbia.

Ontario Paper Co., Ltd., has appointed Dow Chemical Co. as world market sales representative for its vanillin. The Ontario company is building a new \$1.3 million plant at Thorold, Canada, designed to produce 400,000 lb. annually.

NEW NAMES

Thompson Horticultural Chemicals Corp., St. Louis, Mo., has changed its name to Thompson Chemicals Corp.

Midland Glue Products Co., Ferndale, Mich., has changed its name to Midland Adhesives & Chemical Corp.

Alan Porter Lee, Inc., Morristown, N. J., has changed its name to Alan Porter Lee Associates.

NEW FACILITIES

E. I. du Pont de Nemours and Co.—A cellulose sponge plant to be operated by its film department. The plant represents an expansion of the company's present sponge production facilities at Buffalo, N. Y.

Culligan Zeolite Co.—New equipment and additions to its San Bernardino, Calif., plant which will double the company's production of silica gel.

Davison Chemical Corp., Baltimore—A \$7 million plant near Lake Charles, La., to produce catalyst on a large scale for petroleum-cracking refineries. Production is scheduled for early next year.

Eston Chemical, Inc., Los Angeles—A \$50,000 addition to its agricultural chemical plant for DDT, BHC, Toxaphene and other basic insecticide concentrates.

American Cyanamid Co.—An expansion of its microspheroidal cracking catalyst plant near Michigan City. By mid-summer capacity will be 800,000 bbl. daily.

U. S. Rubber's Naugatuck Chemical Division—A Los Angeles plant for rubber latex and plastic materials.

Standard Oil of California—A synthetic phenol plant at Richmond, Calif., to get under construction shortly now that government approval has been obtained. It will produce phenol and acetone for Standard subsidiary, Oronite Chemical Co., using a recently-developed synthesis process in which neither sulphuric acid nor chlorine is used.

Rayonier Inc.—A \$25 million pulp mill with a capacity of 250 tons of purified wood cellulose in Doctorville, Ga. The mill will use an improved process which permits production of superior grades of wood cellulose, primarily for high tenacity yarn applications.

International Graphite and Electrode Corp.—A \$10 million expansion at its Niagara Falls plant which will greatly increase production of graphite electrodes.

Fansteel Metallurgical Corp., North Chicago, Ill.—Doubled capacity to produce tungsten and molybdenum metals. The continuing expansion program will also treble capacity to make selenium rectifiers and increase by one-third the company's output of cemented carbide cutting tools.

Carborundum Co.—Doubled production at its Vancouver, Wash., plant due to a \$3.3 million expansion program.

Reichhold Chemicals, Inc.—A \$1.5 million expansion of its phenol production plant in Tuscaloosa, Ala. A necessity certificate has just been received from DPA.

Vickers Petroleum Co.—A 6,000 bbl. per day thermofor catalytic cracking unit at its Wichita, Kans., plant.

Union Oil Mill, Inc., West Monroe, La.—A chemical solvent plant to increase by 8,000 lb. per day the company's output of cottonseed oil.

Lion Oil Co.—A \$5 million expan-

Hackney MILWAUKEE

for shipping any type of gas

SAFELY and at *LOWER COST!*

Choose Hackney Cylinders—and be sure your products are fully protected—both in transit and in storage. Rugged Hackney Cylinders are deep drawn from quality metals. Skillful fabrication and controlled heat-treating add still further to their strength and durability.

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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

sion program for its El Dorado, Ark., refinery. New process units will include a catalytic cracking unit with integral vapor recovery equipment and a 1,150 bbl. per day alkylation plant.

Humble Oil & Refining Co.—A research center in Houston.

Taylor Fibre Co., Norristown, Pa.—A district office in Pittsburgh, Pa., headed by W. H. Slocum.

Columbia Cellulose Co., Port Edwards, B. C.—An increase in facilities which brings production of high alpha pulp from 200 to 300 tons daily.

U. S. Rubber's Naugatuck Chemical Division—A branch office in Memphis, Tenn., for the sale of rubber and plastic latices.

Selas Corp. of America, Philadelphia—A Pittsburgh, Pa., office under the direction of John L. Wilson.

Sharp & Dohme (Philippines) Inc.—A $500,000 pharmaceutical manufacturing laboratory in Manila.

Olin Industries, Inc.—Advanced research and development laboratories in Pisgah Forest, N. C., to evolve new and improved cellophane, polyethylene and other packaging films.

Hilton-Davis Chemical Co.—An addition to its textile dyestuff laboratory which doubles its size.

Utah Oil Refining Co.—A $1 million expansion program at its Salt Lake City refinery including six new gasoline and crude oil storage tanks with a capacity of 384,000 bbl., two pipe lines and a steam boiler.

Continental Can Co.—Fiber drum manufacturing plant to be built in Pittsburgh, Calif.

Borden Co.—An NPA authorized outdoor type resorcin plant to be built at Dominguez, Calif., estimated to cost $600,000. It will produce at least 500 tons annually.

NEW LINES

Spickelmier Products Co., Chicago—Aerosol products through the purchase of the patents, copyrights, trade names and inventories of the Tetco Co., Hobart, Ind.

Essex Conveyor, Inc., Newark, N. J.—A unit which lifts and dumps any

free flowing material, handles bags, bulk and drums. Essex will manufacture and service the unit for customers east of the Mississippi. Colson Equipment & Supply Co., Los Angeles, has been similarly serving western customers.

Electronic Rubber Co., Stamford, Conn.–Polyvinyl chloride injection molding and extrusion compounds for non-electrical uses.

Acheson Industries, Inc.–Pigment dispersions. Expansion in this direction has been made possible by acquisition of plants in Philadelphia of the Peerless Printing Ink Co. and Synthetic Lacquer & Varnish Co.

Mine Safety Appliances Co., Pittsburgh, Pa.–Radiation detection instruments manufactured by Beckman Instruments, Inc.

NEW COMPANIES

Flexible Metal Hose Mfg. Co., Costa Mesa, Calif., to turn out flexible metal conduit serving a wide variety of shielding applications and flexible metal hose for both fluids and gases.

Erdmann Mixer Co., Matawan, N. J., to design and supply turbine type agitators to the chemical and allied industries.

American Bitumuls & Asphalt Co., to manufacture and sell on a nationwide scale various types of paving asphalts and special asphalt products. The new company is a merger of the American Bitumuls Co. and Stancal Asphalt & Bitumuls Co. Both are subsidiaries of Standard Oil of California.

Heyden Export Corp., a wholly owned subsidiary of Heyden Chemical Corp., to specialize in sales of antibiotics, pharmaceuticals and chemicals in Western Hemisphere countries. Paul van der Stricht has been elected president.

Magnex Corp., Jamaica, N. Y., to manufacture transformers, nuclear instruments, relay mechanisms and other electronic equipment. Company president: Everett Patterson; board chairman: S. R. Sperans.

Fricke and Kazmann, Consulting Engineers, Stuttgart, Ark., to specialize in the integrated development of surface and ground water supplies. Investigations, reports, designs.

Idea For Maintenance Program

Plant maintenance procedures cannot be rightly compared, this engineer discovers, but they can be successfully studied in the light of conditions in individual plants.

"Men, I see you are in a hole. I can't get you out, but I can get in with you."

Calvin Coolidge made this remark to a group of farmers during the depression. But Methods Superintendent Oliver Etheridge of A. E. Staley Manufacturing Co. used it at the recent Plant Maintenance Show in Philadelphia to describe the failure of a project.

"My company is a part of the wet corn milling industry. There are only a few relatively large units in the entire industry, and basic processes and equipment in all plants are very similar.

"Several years ago our company, and some of our competitors, undertook a project of comparing our maintenance cost data through the cooperative effort of maintenance engineers, accountants, and some top executives. We all wanted to know whether our maintenance costs were reasonable; and there was hope that the comparisons would furnish pertinent information directly applicable to maintenance cost reduction.

"Insofar as accomplishment of the desired ends, the entire project was a complete failure. The failure was not that comparative figures could not be developed; the failure was that we could not find conclusive significance for the comparisons."

From the ashes of this experiment, Etheridge uncovered some of the factors that make such comparisons of little value. And he uses these factors as an argument for his conslusion:

"The effectiveness of a maintenance program can be judged only in relation to the physical conditions and management policies prevailing in the particular plant."

Maintenance of any particular piece of equipment depends upon both its design and its use, he claims. But maintenance may also be greatly affected by the operating and financial policies of the particular company. Maintenance is just a part of business; and "until we begin to consider the combination of production cost, maintenance cost, and the capital structure of our business, the apparent cost of maintenance is apt to be misleading."

VARIABLE FACTORS

Starting with a few variable factors that have impact on maintenance cost data, here is Etheridge's argument:

Accounting procedures: Accounting procedures vary widely, and although they may all satisfactorily serve the purpose of financial guidance to top management, there is often need for the establishment of special accounting procedures to furnish the analysis of maintenance we now desire.

"The effectiveness of a maintenance program can be judged only in relation to the physical conditions and management policies prevailing in the particular plant."

Wage policies are so different and changing that maintenance labor can be measured as manhours better than dollar cost.

Labor policy as regards accepted level of productive effort of manpower.

Labor policy as regards separation of work by trade skills vs. general maintenance men.

Policy as regards high replacement vs. high maintenance. Some companies, as policy, run equipment to destruction and replace with new equipment, whereas other companies try to maintain the same type equipment at near new mechanical effectiveness.

Plant safety policies: The requirements for guards, interlocks, and other safety devices that have no productive value, but tend to increase maintenance costs.

Plant appearance policy as regards maintenance for show purposes or maintenance only for functional effectiveness.

Production policy: Some companies have an excess of machines to allow effective use of labor, whereas other companies have excess labor to insure maximum use of machines. The maintenance problems are quite different.

If no one can furnish reference data by which we can judge our maintenance performance, we should not be discouraged. There are untold opportunities for developing our own standards of reference for our own plant and for our own needs. We can always establish a basis of judging present conditions and predicting the future by comparison with our own past operations.

Our first step in maintenance analysis was a new classification of accounts for the job orders used with all maintenance work. These accounts depend only on the class of work done, and are not related to the depreciation and taxation problems which enter into our accounting for financial purposes. These classifications are:

Improvements: changes and additions to productive processes (new construction).

Experimental.

Alterations: process changes involving no maintenance or additional process equipment.

Service: general service to productive departments.

Major replacements: replacement of buildings or equipment in kind when change exceeds 50 percent of original value.

Tools.

Safety.

Fire damage restoration.

Repairs: repairs, adjustments, minor replacements.

Outside work.

Special jobs: plant services not associated with production.

These classifications, with routine recaps of totals, allowed analysis of the trends and changes in the maintenance department expenditures as a whole.

The plant is also subdivided by buildings and department on a basis of the divisions in production supervision. At regular intervals each operating supervisor is furnished a record of the maintenance manhours and materials furnished to his department by class of jobs and totals.

The reason for this continuous reporting: Process supervisors share in the responsibility for maintenance costs within their departments. Also the best analysis of maintenance effectiveness is gained by continuous

observation of small units of our plant.

By focusing our attention to the smaller divisions of our plant, we find that each department has its particular problems that furnish a challenge to our engineering skill to find better methods, better materials, and equipment more suited to our needs.

Besides departmental analysis, we have undertaken several general projects applicable to the entire maintenance department. The first such project was the improvement in communication, transportation, and clerical procedures in developing and transmitting work orders.

A recent plant enlargement included building new centralized shops for all divisions of the maintenance department. At this time we installed two-way radio communication between the job dispatching center and our maintenance trucks and cranes. We also installed a pneumatic tube system for transmission of written orders between the shops and the work dispatching center. Both of these developments have proved effective for our plant.

A second major project has been the analysis of our use of skilled labor. To do this we are using several trained time study men to continuously sample our performance and establish the distribution of the workman's time. This investigation has revealed some very interesting facts.

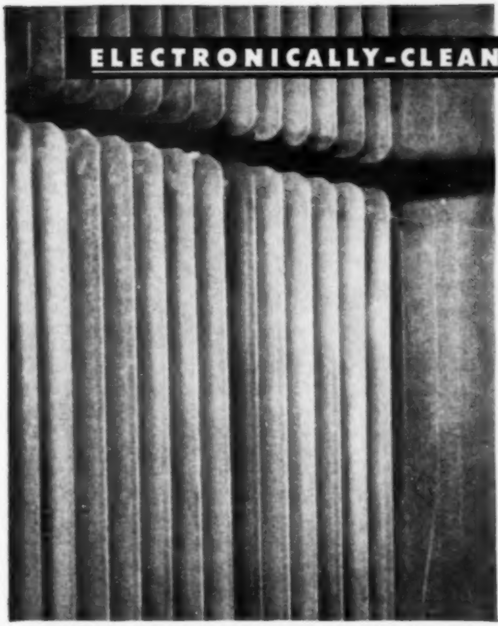
First, it revealed a net effectiveness of only 65 percent. Second, it revealed that the primary cause of lost effectiveness was managerial rather than any unwillingness of the workmen to do their part. Third, it was found that insufficient and inaccurate information in the original work orders was the greatest single cause of lost time and wasted effort of the maintenance workman.

These findings led to the third major maintenance project: that of improving our work orders and obtaining more effective planning and scheduling. This project is still in its infancy, but the analysis and experiments made to date indicate the possibility of important changes in procedure.

Previously, most work orders were originated by production foremen and supervisors. Any apparent complications were field checked by assistant foremen from maintenance shops before assignment of workmen. The volume of orders was too great to allow preliminary field check of all orders.

It was soon found that the original work orders, as prepared by production rather than maintenance personnel, did not reveal the orders that did

ELECTRONICALLY-CLEAN AIR FOR INDUSTRY



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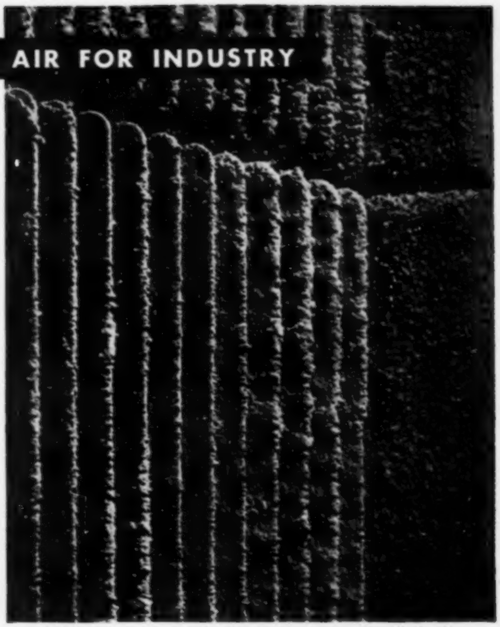

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QED, cont. . .

and did not require field check prior to assignment. There were but two solutions: either field check all work orders, or improve or change the source of the original orders. Before arriving at a tentative solution we found ourselves confronted with three pertinent questions:

Can production personnel be expected to furnish work orders in sufficient accuracy and detail to avoid complete recheck by trained maintenance personnel?

To what extent should productive supervision be responsible for maintenance of equipment within their productive control area?

Should work orders be reasonably complete when they are originated, or should a request for service made by nontechnical personnel be followed by a technical man to inspect and write the order?

EXPERIMENT

As an experiment, we placed men of the rank of assistant foreman from the maintenance shops as maintenance area supervisors in certain divisions of our plant. These men, though under the direct control of the maintenance department, were assigned as staff assistants to the production foremen of their assigned areas. Their duties:

Inspection of equipment.

Consultation with production supervision as to need and urgency of corrective action.

Consult with and advise maintenance shop foremen of special problems beyond their scope in experience.

To prepare work orders, including —complete description of work to be done with recommendation of replacement, field repair, or shop repair; furnish size and type of equipment involved; list material and special tools required for work (sketches if helpful); estimate type and number of workmen required; furnish schedule of availability for maintenance of process equipment.

RESULTS

In the areas where these experiments are being made, we had the following promising results:

The area maintenance supervisors are rapidly becoming a one-man channel for all maintenance problems in the area, eliminating multiple communications which were often so unsatisfactory that they created a barrier of lack of confidence between maintenance and production departments.

The quality of work orders is so much higher that it will take some time to realize the full potentialities

of the new plan in improved planning and scheduling.

The inspection of equipment is far superior to that obtainable, either from production personnel or shop located inspectors.

The special skills of the maintenance shop foremen are more effective when the need for such skills is more clearly recognized by the higher level of field inspection.

Last, but not least, we foresee in the area supervisor of this level the possibility of developing preventive maintenance schedules of regularly recurring work orders. We believe that this would not eliminate the need for this type maintenance organization, but it would allow enlargement of the territorial coverage of each man.

HERBICIDES

... *A Question of Population*

Actually how useful are today's herbicides? The organic gardening school, stoutly represented by author-farmer Louis Bromfield, does not believe in them. On the other hand, the realists, forcefully championed by the Department of Agriculture, claim they have an essential part in our agricultural economy.

Last month the department's research administrator Byron T. Shaw, before the Southern Weed Control Conference in Atlanta, got off some hard facts:

"Recent experiments in Ohio . . . A corn field treated chemically to control weeds produced 111 bushels to the acre. A similar plot with weeds uncontrolled produced 87 bushels. In another experiment, weed competition reduced yields from 80 to 30 bushels, a loss of 41 bushels or more than half the crop.

"Work reported from South Carolina is even more striking. With 2,4-D to control weeds, 33 bushels per acre were produced on land that yielded only 9 bushels when weeds were unchecked.

"In one Oklahoma area where sagebrush was controlled and the pastures were improved, beef production went up 50 percent.

"We need fundamental research on plant growth, for example, to find out why present compounds kill 99 percent of the tops of mesquite in some places, but only 50 percent of the roots.

"The pressure is on us. With demands for 1952 production the highest in history, farmers can't wait 5 or 6 years for us to get all the "ifs" and "buts" straightened out. They need results.

"Our farmers will have to produce

YARDSTICK

"Modern life requires that we use daily in industry, in business and in our homes many tools and materials which possess inherent capacities to injure health. The extent to which we can use them with minimum risks to ourselves and others might be considered a measure of our social advancement."

John M. Foulger
Director of Haskell Laboratory
E. I. du Pont de Nemours & Co.

more, and still more, in the years ahead. Our growing population is the reason. We're now growing at the rate of 2½ million people a year. If that sounds like just another figure to you, try to imagine a city like Atlanta springing up to full size in a little over two months."

ADSORPTION

. . . *From Coconuts to Coal*

Coconut shell is extremely dense. In the form of activated charcoal, it gives a high purifying effect per unit volume. Before the last war, the Army found it an ideal filler for the gas mask canister. But when the war came, the Japanese moved in on the major source of supply.

At a recent meeting of Chapter, Alpha Chi Sigma, in Baltimore, Brig. Gen. Charles E. Loucks, deputy chief chemical officer, told about the problems of finding a substitute.

"On a weight-for-weight basis, we could make a usable charcoal from ordinary oak wood. But we didn't use it because a gas mask canister using it would be too bulky to carry around. Great adsorptive capacity is required in our activated charcoal.

"A poor substitute for coconut shell can be made from anthracite and semi-anthracite coal, but these substances, after they are activated, have too great a percentage of ash. The soldier would be carrying around one-third activated charcoal by weight and two-thirds by weight of dead ash. So that would be a poor solution.

"When we tried to make activated charcoal from bituminous coal, in the normal manner, it swelled as it does in coking, and we were unable to produce a satisfactory product. However, as a result of a great deal of experimentation, it was found that good quality soft coal could be slightly oxidized prior to carbonization and the oxidized coal then did not swell when it was carbonized.

"In this way it was possible to

QED, *cont.* . . .

maintain the structure of the coal or wood substance quite as well as in coconut shell. Then by further treatment a splendid type of activated charcoal for use in gas mask canisters was obtained."

RESEARCH

. . . *The Ideal Vat Dye*

Search for the perfect vat dye has gone on apace since the discovery of indanthrone by Rene Bohm in 1898. Yet despite intensive research, the ideal vat dye like the ideal woman, cannot be found.

Last month American Cyanamid's *Dyelines and Bylines* offered notable help. They defined the ideal:

It must of course display an attractive or useful shade and must be producible by a commercially practical and economical manufacturing process.

It must deserve a fastness rating of 5 to all the usual destructive influences such as laundering, bleaching, dry cleaning, etc. and its fastness to light must be at least 7 in pale shades and 8 or more in medium and dark shades.

It should be applicable from dyebaths at temperatures between 70 and 140 deg. F. without too much variation in strength and shade.

The color yield and shade should not vary excessively when the dye is applied from dyebaths varying between about ½ oz. and 1 oz. of caustic soda per gal.

It should be inherently level dyeing.

The sodium leuco compound should possess good solubility and good stability.

The ideal vat dye should not change shade greatly when soaped after dyeing.

The dyed shade should not be sensitive to moisture, heat, or finishing treatments.

The shade should be similar in tone when viewed by either daylight or artificial light.

The ideal vat dye does not acceler-

OILCLOTH

"It is now possible to completely clothe a man in oil. For example, he could wear nylon underwear, dynel socks, an orlon shirt, a dacron tie, a dacron or acrilan suit, and shoes from nylon with styrene soles."

GUSTAV EGLOFF
Research Director
Universal Oil Products Co.

ate tendering of the fiber when a dyed fabric, either in the leuco state or the fully oxidized state, is exposed to sunlight. Neither should it undergo a permanent shade change when struck by light while in the leuco state.

There also are other desirable properties which can be considered, such as dyeing behavior on fibers other than cotton.

FLUID FLOW

. . . *Reducing Water Hammer*

To completely eliminate water hammer is not always practical. But objectionable noises can be eliminated, and reasonable safety limits established.

To do this, engineers F. C. Petrie and F. P. DeCraene of Crane Co. advise:* provide for slow closure of valves, or install a hydraulic shock absorber close to the source of water hammer.

Hydraulic shock absorbers may consist of spring loaded relief valves or any of the numerous commercially available devices. Some have rubber bags or sleeves or metallic bellows containing air or other compressible gases to absorb the shock.

Spring loaded relief valves must operate rapidly to effectively reduce pressures. Probably the most common and economical shock absorber in use, particularly on small size lines, is the air chamber constructed of a vertically mounted and capped length of pipe, usually one or two sizes larger than the pipe to which it is connected. However, the diameter of the air chamber is not important if excessively high air chambers are avoided.

The connection between the air chamber and the pipe is usually the same size as the pipe. But experiments have indicated that a restriction at this point not exceeding one half the diameter of the pipe is beneficial.

Re-charge air chambers periodically, because entrapped air gradually dissolves in the water or escapes due to leakage. In recharging, simply drain the lines and allow the chambers to refill with air.

In installations where it is not considered practical to drain the lines, provision for recharging should be made by a suitable arrangement of valves on the air chamber.

General Recommendations: For selecting material for shock service, Petrie and DeCraene suggest:

When using valves and fittings in lines where shock is likely to occur, the maximum increase in pressure due

* *Valve World*, Crane Co., No. 3, 1951.

QED, *cont.* . . .

to shock should be added to the static pressure in determining the safety factor. Remember that brittle materials such as cast iron, etc., are subject to fatigue, and, therefore, the factor of safety over maximum pressure should prevent failure.

The use of the proper size of hydraulic shock absorber or other means of eliminating shock is strongly recommended.

INSTRUMENTS

. . . No Pry Without Priorities

Users of scientific instruments and laboratory apparatus are urged to apply priority ratings to their orders.

Bare spots are showing up on shelves of instrument and apparatus distributors all over the country. Manufacturers' stocks of raw materials are practically cleaned out, warns Kenneth Andersen, executive vice president of the Scientific Apparatus Makers Association.

In its M-71 order, NPA classes the industry as "essential." All laboratories can use priority DO-X1 to get instruments.

Despite this, instrument makers are being cut back drastically in their allocations of copper, brass, stainless steel and other nickel alloys. Cutbacks result partly, manufacturers believe, from their inability to get priority orders from distributors.

Distributors, in turn, blame their difficulty in getting priorities from users on the fact that users shy away from the added paper work or dislike controls in general.

Further, despite World War II experience, NPA has not issued distributors a rating to replenish shelf stock.

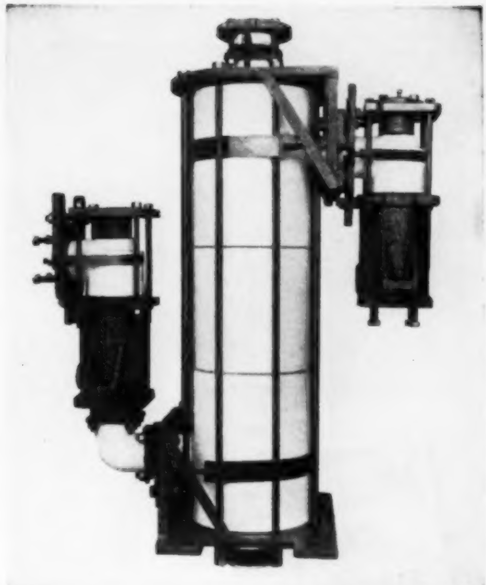
Manufacturers believe their allocations are determined almost entirely by the priorities pattern they can present. They get raw materials for practically 100 percent of A, B, C and E-rated orders. DO-X1 and MRO orders run a bad second, and the nonrated ones get little consideration at all. *(Continued)*

A NEW ADDITION

"The chemical engineer of today is not primarily a design engineer of equipment or a process . . . He has become a part of management and is called upon to perform practically every duty that management is called upon to do."

WILLIAM I. BURT
President
American Institute of Chemical Engineers

Worthington two-stage non-condensing ejector—porcelain



Worthington two-stage condensing unit—porcelain

How To Maintain an Uninterrupted Vacuum

in the presence of corrosive vapors

Use a Worthington corrosion-proof steam-jet ejector. These are made in stock sizes and specially engineered for handling any corrosive vapor problem in the chemical field.

For corrosive vapors, these ejectors are made with impervious graphite nozzles and diffusers. Suction chambers are of porcelain, but these can also be furnished of impervious graphite. Porcelain diffusers are also available.

For corrosion-*resistant* usage, Worthington makes ejectors of bronze, stainless steel or Worthite (a special Worthington "super-stainless").

Worthington's is the *most complete* ejector line. A model for every vacuum requirement—from atmospheric to 50 microns absolute. Single and multiple stages. Condensing and non-condensing.

Put your problem—distillation, drying or any other vacuum problem—up to Worthington Pump and Machinery Corporation, Steam Power Division, Ejector Section, Harrison, New Jersey.

WORTHINGTON

STEAM POWER DIVISION

X.1.2

QED, *cont.* . . .

GOING NO PLACE FAST

"Half of the engineering school graduates are being taken into the Services, one way or another. This means that as far as filling the demand for engineers goes, we are taking two steps forward and one backward. On the one hand our Government deplores the shortage of engineers, while on the other it makes it impossible for the colleges to produce a full crop. Sometimes I wonder if we aren't with Alice beyond the Looking Glass where we must 'run awfully fast to stay in the same place.'"

Blake R. Van Leer,
President
Georgia Institute of Technology

Despite NPA denials, company after company reports its allotments appear to be based directly on priority patterns. Competition has, in recent weeks, caused dealers to fill unrated orders of their major customers from shelf stocks, according to Andersen. Now these stocks are universally low. The pry of competition can no longer get a customer an instrument without a priority.

AEC was a recent victim of this policy. An AEC order for a conductance bridge, given to one of the nation's biggest distributors, had to wait months until that distributor accumulated enough priority orders from other customers to permit a minimum run of 25 instruments by the producer. Normally, such a bridge would have been stocked. —*End*

THERMODYNAMICS

Continued from page 154

of calculated and experimental temperatures. The calculated temperature curve was reckoned from pressure curve and theoretical curve of Fig. 7.

Classical thermodynamics assuming constant total temperature for all flow involves two misunderstandings:

First, it assumed that an amount of energy $E/P_oV_o = \gamma/(\gamma - 1)$ always came from a space with each pound of gas. Actually, this can be as little as 0.94 of this much at times.

Second, it was thought that the impact temperature measures total energy E. As shown by Figs. 4 and 7, it measures only kinetic and thermal energy and is unconscious of transmitted energy. Result has been an elaborate system of velocity corrections for impact thermometers that were far from convincing.

Space Flow of Fluids—When fluids in space already flowing at conditions 2 have to adjust to new conditions 3 as when leaving the nozzle of Fig. 5,

it is again space flow at constant momentum.

$$\frac{W}{g} v_2 + P_2 a_2 = \frac{W}{g} v_3 + P_3 a_3 \qquad (60)$$

For steady flow

$$W = a_2 v_2 / V_2 = a_3 v_3 / V_3 \qquad (61)$$

Eliminating areas gives

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_2 V_3}{P_3 V_2} \right)^{1/2} \frac{N_2}{1 + 2N_2^2} \qquad (62)$$

For gases this becomes

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_3}{P_2} \right)^{\frac{\gamma-1}{2\gamma}} \frac{N_2}{1 + 2N_2^2} \qquad (63)$$

For liquids it is

$$\frac{N_3}{1 + 2N_3^2} = \left(\frac{P_3}{P_2} \right)^{1/2} \frac{N_2}{1 + 2N_2^2} \qquad (64)$$

Fig. 8 shows this space flow pressure function $N/(1 + 2N^2)$ has a peak value at $N = (1/2)^{1/2} = 0.707$. From either Eq. (63) or (64) it may be seen that a fluid flowing in space toward a lower pressure P_3 can do either of two things, depending on the initial N_2. If N_2 is less than 0.707, the flow will flow to the lower pressure at decreasing N_3. If N_2 is greater than 0.707, it will flow into the lower pressure with an N_3 greater than N_2.

If pressures are eliminated from Eq. (63), the result for gases is

$$N_3 \left(\frac{N_3}{1 + 2N_3^2} \right)^{\frac{\gamma+1}{\gamma-1}}$$

$$= \frac{a_2}{a_3} N_2 \left(\frac{N_2}{1 + 2N_2^2} \right)^{\frac{\gamma+1}{\gamma-1}} \qquad (65)$$

and for liquids

$$N_3^2/(1+2N_3^2) = (a_2/a_3)[N_2^2/(1+2N_2^2)] \qquad (66)$$

These area functions and the pressure functions of Eqs. (63) and (64) are shown on Fig. 8. By using these curves with their corresponding equations space changes of flow can be readily calculated. If N_2 is known, the appropriate function of N_2 from Fig. 8 can be multiplied by the appropriate area or pressure ratio to obtain the corresponding function of N_3. Thus N_3 can be picked off of Fig. 8. This procedure can be reversed.

Since the area function for liquids has no peak value, any space flow approaching a pressure region P_3 less than P_2 will continue to increase in velocity ratio if the original N_2 is greater than 0.707. If it approaches at less than $N_2 = 0.707$ it will decelerate into the lower pressure region. When accelerating, its area decreases and it receives energy from space. When decelerating, its flow area increases and it yields up energy to surrounding space.

This is the basic phenomenon of

inlet cavitation of pumps. If the flow approaches the minimum pressure region of a blade curve at $N_s > 0.707$, it will suddenly accelerate to a very low pressure. Typical tests[5] of $N_s = 1.0$ flow attempting to pass around a -12 deg. turn show the absolute P_s to go as low as 2 in. Hg.

With ordinary water supplies at normal temperatures, when a pressure of much under 2/5 of an atmosphere is reached, air suddenly flashes out of solution. Once this process starts, violent surging occurs.[4]

When velocities are high in pump and turbine inlets, supercharging the inlet to a higher P_s has the effect of decreasing $N_s^2 = v_s^2/2gP_sV_s$ to a safe value.

Fig. 8 shows that the area function for gases, Eq. (65), increases up to $N = (\gamma/2)^{1/2}$ or 0.8367, and then decreases as N increases further. This means that, when gas flow approaches the rapidly changing section of an airfoil or compressor blade at a local $N_s > 0.707$, space flow will accelerate with decreasing pressure and area until $N_s = (\gamma/2)^{1/2}$ is reached. When this point is reached further acceleration calls for an area reversal in space which terminates in discontinuity and unstable behavior.[1,6]

This same effect also shows up in nozzles when the supply pressure P_s is raised above the critical ratio shown on Fig. 6. For the nozzle represented by Fig. 5, whenever N_s exceeds $(\gamma/2)^{1/2}$, P_s rises above P_s. Repeated tests[3] of such nozzles reveal visible shock diamonds soon after P_s exceeds P_s.

When air at various values of N_s above 0.707 is asked to pass around -6, -10 and -12 deg. turns the same checks are observed[5]. In the range from an approach N_s of 0.60 to 0.70 the flow is noisy, erratic and often unstable, but once the transition occurs little noise is present. Velocity and impact temperature traverses verify energy transfer inward from the outer stream tubes. Velocity near the surface increases greatly and decreases further out, and the same is true of impact temperatures.

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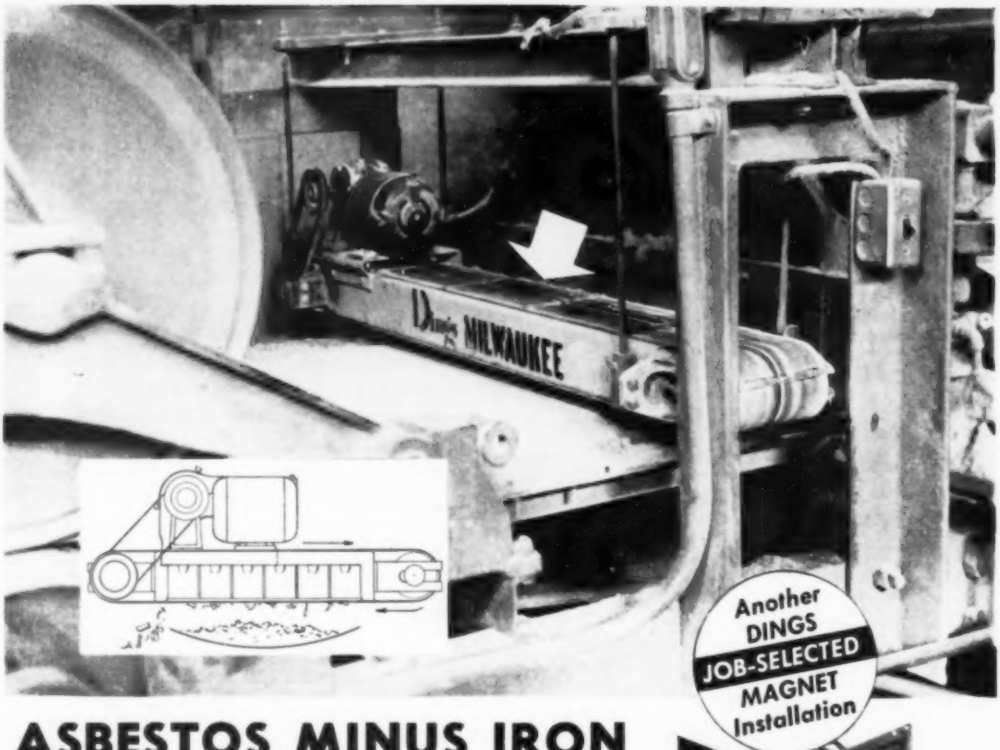

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DINGS MAGNETS DO THE SUBTRACTING

HOMEOWNERS like the superior quality of asbestos shingles but if the shingles don't look like wood, they won't buy, says one of the biggest manufacturers of asbestos building materials in the business. So the shingles are passed through engraving rolls to give them the textured appearance of wood. A problem raised by this process and solved by a Dings self-cleaning non-electric Perma-Plate magnet (big illustration) is TRAMP IRON—nuts, bolts, wires, etc. which get in the asbestos during previous processing. This iron would wreck the rolls, alter the pattern and eventually cause rust spots in the installed material. The Perma-Plate gets it all out—automatically.

WHY was the Perma-Plate selected for this job over all other types and styles of magnets in the Dings line? *The specific application dictated its choice.* The magnet was "job selected." Whatever YOUR tramp iron problem, buy a Dings job selected magnet and KNOW it will be successful.

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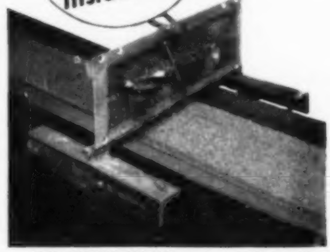
4730 W. Electric Ave., Milwaukee 46, Wis.



THE PERMA-PLATE (shown here without self-cleaning attachment) is non-electric, permanently magnetic. This magnet is particularly effective where the burden depth does not exceed 3".

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Is the material you want de-ironed a solid . . . semi-solid . . . liquid? Is it carried in chutes . . . ducts . . . conveyor belts? Catalog 5000-B lists Dings complete line by application, describes all Dings magnets from the low cost, non-electric "Perma" Plate magnet to the most powerful magnetic separators known. Send for it today.

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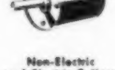
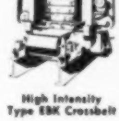


Non-Electric and Electric Pulleys

Non-Electric Drums



High Intensity Type EBK Crossbelt

Chemical Engineer's Bookshelf Edited by Lester B. Pope

14 Steps to Better Process Control

You can use the new tool for industrial process control. It is not as formidable as you may have believed. It can be easily learned and intelligently applied.

Late last month "Industrial Process Control by Statistical Methods"* made its debut. At a luncheon given by the publisher I had the pleasure of meeting the author and discussing your problems with him.

John Heide, who is industrial-statistical analyst at U. S. Rubber Co., is a sincere and ardent advocate of a very young philosophy. He tells us that the new philosophy is based on the belief that the pattern of variation seen in processes operating under stable conditions can be described and analyzed by the methods of analytical statistics. This analysis and the taking of action therefrom gives us a new concept of process control. In many processes it will save manpower, machines, minutes, money.

Mr. Heide admitted to me that you and I differ with him in our understanding of the word "process." To him it means turning out products such as nuts or bolts or inner tubes. To us it indicates alkylation or some other change in composition. We quickly arrived at a definition: the word "process" means "making something." So it belongs to chemical engineering just as it does to manufacturing. So, too, can statistical methods be applied to chemicals as well as to candies, cosmetics, cotter pins or cars.

So we can agree that the chemical process industries are industrial processes. Now we can start learning about statistical methods and how to apply them. They are not as formidable as you may think. Let's dispel a misconception. We are not going to police our process between a couple of arbitrarily fixed limits. We will set up an ideal and supply enough auxiliary information to help in reaching it. Here are the 14 steps.

1. INTRODUCTION

There are three phases of process control by statistical methods: (1) Analysis of a variation to see what its pattern would be under stable operating conditions. (2) Separating variations into expected and unexpected with attention on the latter. (3) Correcting causes for the unexpected variations.

The result is maintenance of a variation within the limits set up by the method.

2. PRESENTING DATA

Process data usually have to be summarized and digested before they can be interpreted correctly. Statistical methods can reduce the mass of data in two ways: computational and graphic. Results are easy to grasp and they will be interpreted the same way by everyone.

3. FREQUENCY DISTRIBUTIONS

Source of all information is measurements made on the process. It may be during processing. But control may be more easily obtained by measurement on finished product. These measurements—of some characteristic—will fall into a pattern if the process is operating under stable conditions. This pattern can be described by a distribution curve which can be built by any of several common methods.

A normal frequency distribution has an average and a standard deviation which serve to completely define it. The average determines the level of operation and the standard deviation describes the nature of the variation around the average.

4. CONTROL CHARTS

Some element of the process must be taken as the unit for control. You draw process average lines and limit lines on a chart which has provision for both scale of measurement and the scale of either time or sequence of production. Observations from the process are plotted. The mosaic of points becomes the basis of process control. It is the control chart.

5. LIMIT LINES

Boundaries on distribution curves must be ascertained from study of a process. They are not set arbitrarily. They direct attention to the process when necessary. They prevent tinkering with the process when observed fluctuations are inherent in the process. They help in quality improvement by assuring that operation doesn't deteriorate and by improving quality level.

6. OPERATING SPECIFICATIONS

Specification standards can be of four types: (1) minimum value specified, (2) maximum value specified. (3) both, (4) both plus a central value specified. In many cases the requirements imposed by these specifications are unrealistic. In this case we should find out if the product produced under statistical control would meet requirements.

Specification or tolerance limits are intimately related to control chart limits. And to economic levels of production.

7. TECHNICAL PROBLEMS

All action is based on observed measurements. Therefore sampling and measurement have to be done properly. Type and design of control chart also receive proper attention because it will be used for graphic interpretation of process data.

8. STUDY OF PROCESS DATA

First step in the plant application is a study of process data. Objectives: (1) Estimation of frequency distribution. (2) Determining appropriate group size and sampling sequence. (3) Weeding out causes of non-random variations. (4) Computation of provisional limits. (5) Establishment of provisional control procedure.

9. PLANT INSTALLATION

Now you must be careful to get your new program started right. It will be examined critically by workers as well as management. You will be quite successful if you read a talk prepared for you to make (p. 173) by Mr. Heide.

After initial success, control can be expanded to other units of one operation and then to other operations.

10. PRACTICAL PROGRAM AIDS

You will have to organize: machinery for corrective action, periodic review of limit lines, chart display and

---

* INDUSTRIAL PROCESS CONTROL BY STATISTICAL METHODS. By John D. Heide. McGraw-Hill Book Co., New York. 397 pages. $6.

distribution, continued instruction, and records.

11. FACTORY USE OF CHARTS

Factory, as well as engineering, interpretation is needed for charts. They help remove or compensate for recurring causes of variation. They find shifts in levels, units operating at the wrong levels, trends. They give graphic comparisons of quality.

12. ORGANIZATION

Three plant functions exist: producing, inspecting, process control. One of these departments may be assigned the task of maintaining efficient conditions. This group would be given the assignment of improving process control by the use of statistical methods. Authority varies as needed. Responsibilities of the group can be delineated.

13. REPORTING & RATING

The control chart itself is efficient in conveying process information. Management, however, should get summations and evaluations of control chart information.

After defining quality characteristics, you can rate the product from the standpoint of its quality evaluation by the consumer.

14. EVALUATION OF TESTS

Study the reliability and accuracy of test results. Improve test methods, maintain testing and measurement performance at a high level of precision.

OUR EVALUATION

As you have already guessed, these 14 steps which we have been discussing are the 14 chapters in Mr. Heide's new book.

Last month the author told me that statistical methods can be applied to the problems of industry in three ways: process control; acceptance of material by sampling; design and analysis of experiments. He has covered the first of these in this book. (He denied that he was interested in writing more books to cover the remaining two categories.) He has done it well, too. Men in plants without statisticians will appreciate Mr. Heide's efforts in their behalf. Industrial or other engineering students, if they are assigned this book, will benefit by its clarity.

The author is interested in getting statistical methods more widely used. His efforts appear to be in the right direction. And although our sampling of his book is far from random, it shows a high level of quality and predicts a probability of success.—*LBP*

Recent Books & Pamphlets

Subject	**Summary**	**How to Order**
Battle For Production	Survey of the chemical industry at the halfway mark in its huge program for putting up plants to turn out the chemical goods for an arsenal economy. CE's annual review of the technological and economic status of the industry. Sections on: plant and facilities; processes and technology; mobilization; labor; profit and loss; supply and demand. Numerous graphs; extensive tabulations of new plants and facilities, new processes and technology, 1950-51. 48 pages.	Reprint No. 186. Editorial Dept., *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y. $1.
Air Pollution	Its physiological effects upon man, animals and vegetation. Listing of recommended maximum allowable concentrations in the atmosphere for 144 different chemical substances.	"Air Pollution Abatement Manual, Chapter 5." Manufacturing Chemists' Assn., 15th and H Sts., Washington 5, D. C.
Ceramics	Tables of physical properties of chemicals used in the ceramics industry. Formulas, molecular weights, colors, crystal forms, densities, refractive indices, melting, boiling and transition points, decomposition temperatures. 193 pages.	"Data on Chemicals For Ceramic Use." Publication Office, National Research Council, 2101 Constitution Ave., Washington 25, D. C.
Raw Materials	Articles on California's contribution of mineral raw materials to San Francisco industries should make this report of interest to present or future operators of chemical plants in the San Francisco Bay area. Among the subjects discussed: salines, mineral fuels, limestone in the cement industry, the building stone and aggregate industry, clay in the ceramic industry, manganese and quicksilver. 392 pages.	"Geologic Guidebook of the San Francisco Bay Counties." Bulletin 154, California Dept. of Natural Resources, Division of Mines, Ferry Bldg., San Francisco 11, Calif. $2.50.
Safety	For the pulp and paper industry, a detailed analysis of hazards and of injury rates for 1948 by region, plant size and operating departments. 58 pages.	"Injuries and Accident Causes in the Manufacture of Pulp and Paper." Bulletin 1036, Dept. of Labor. Superintendent of Documents, Washington 25, D. C. 30 cents.
Economics	Ten-month report on the ESA, January to November 1950. Discusses the operations of price, wage, salary and rent stabilization. 40 pages.	"Strong Dollars." By Eric Johnston. Superintendent of Documents, Washington 25, D. C. 25 cents.
Standards	A presentation of 140 documented case history studies illustrate specific savings and production benefits directly attributed to standardization in American industry. Prepared for ECA to encourage European manufacturers to adopt U. S. production methods. 32 pages.	"Dollar Savings Through Standards." American Standards Association, 70 East 45th St., New York 17, N. Y. $1.
Defense	Fire service and radiation. Nuclear theory, atomic explosion effects, monitoring instrumentation, protective safeguards. 48 pages.	"Radiation & Monitoring Fundamentals for the Fire Service." International Assn. of Fire Chiefs, 22 East 38th St., New York 16, N. Y.

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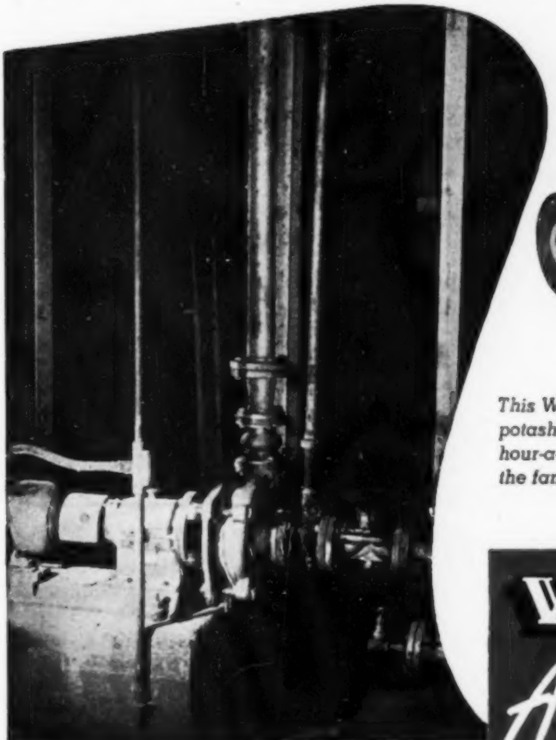

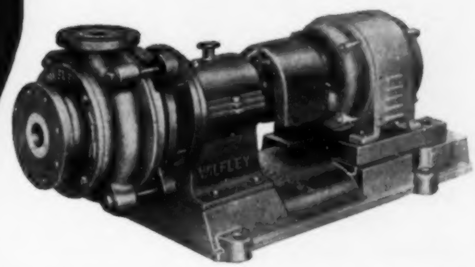

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Subject	Summary	How to Order
Research	Guide for research administrators. Thirteen papers discuss such topics as the training of young researchers, the university's role, the effect of the national manpower policy, coordination of research and development work. 274 pages.	"Selection, Training, and Use of Personnel in Industrial Research." Edited by David B. Hertz. King's Crown Press, 2960 Broadway, New York 27, N. Y. $4.50.
Sodium Chlorate	Known hazards of sodium chlorate and its potentially explosive characteristics. ICC packing, handling and labeling specifications. 12 pages.	Chemical Safety Data Sheet SD-42. Manufacturing Chemists' Assn., 246 Woodward Bldg., Washington 5, D. C.
Hydrocarbons	Scope, results and plans for varied chemical engineering research studies on the natural hydrocarbons.	"Petroleum and Natural Gas Research Program, Fiscal Year 1950." Circular 7616, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.
Pharmaceuticals	British pharmaceutical industry representatives view and analyze all operations subsequent to the manufacture of the essential chemicals necessary to prepare pharmaceutical products for the market. Their recommendations as to what should be adopted at home. 68 pages.	"Report of the Anglo-American Productivity Team on Pharmaceuticals." Assn. of British Chemical Manufacturers, 166 Piccadilly, London, W. 1., England. 3s.
Manpower	Present supply of and demand for engineering skills. Functioning and interrelationship between various governmental agencies and committees concerned with technical manpower. A series of papers and bulletins bound in one folder.	"Engineering Manpower Convocation." Engineers Joint Council, 29 West 39th St., New York, N. Y.

HIGHER PRODUCTION RATES

Continuously

WITH FEinc STRING FILTERS

Because they make filtration a *really* continuous process, FEinc rotary vacuum filters consistently turn in records of increased production with lower costs, better quality.

For example:

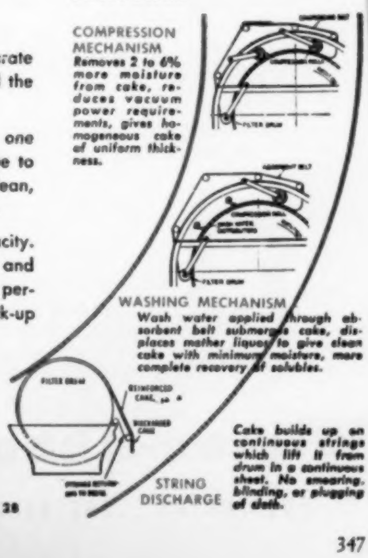
Removing sulphates from a heavy, gelatinous cake required nine separate stages of filtering on an ordinary rotary vacuum filter. FEinc produced the same result in only five stages, increased production almost 100%.

Two scraper type filters handling black iron oxide were replaced by one FEinc of same size. Scrapers partially blinded cloth, gave wet mud due to blowback of filtrate into cake. FEinc, with washing mechanism, gives clean, dry cake, keeps cloth open for efficient filtering. No blowback, either.

Scraper filter handling calcium carbonate gave wet cake, had low capacity. Cloth life never exceeded 30 days. Switching to FEinc String Discharge and FEinc Compression Dewatering Mechanism eliminated scraper wear, permitted use of lighter, more efficient cloth. Filtrate was clearer, cake pick-up better, and cloth lasted 50% longer!

Send for free bulletin 103!

FAMOUS FEinc PRODUCTION-BOOSTING FEATURES



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to Meet Your CITRIC ACID Needs!

Now Available:

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CITRIC ACID ANHYDROUS
SODIUM CITRATE VIII GRANULAR
SODIUM CITRATE U.S.P.
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FERRIC CITRATE
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The use of citric acid as a raw material for new industrial applications ... plus the growing requirements in food, beverages and medicinals ... have greatly increased the demands for this chemical in recent years.

To meet these growing needs, Chas. Pfizer & Co., Inc. has recently expanded its citric acid producing facilities at Groton, Connecticut. At present, this new plant capacity assures you of ample supplies of citric acid and its derivatives. For your requirements, phone or write:

CHAS. PFIZER & CO., INC.
630 Flushing Ave., Brooklyn 6, N. Y.
Branch Offices: Chicago, Ill., San Francisco, Cal., Vernon, Cal.

Manufacturing Chemists for Over 100 Years

PFIZER QUALITY

PFIZER®

Chemical Economics

How Do We Stack Up?

Will chemical firms hold their own in the uncertain years ahead? Will they have to go into debt to finance expansion projects? What about other manufacturers?

Gleaned from the fifth annual survey of business' plants for new plants and equipment prepared by the McGraw-Hill Department of Economics are the following comparisons of how chemical firms stack up with manufacturing in general.

By chemical firms we mean here firms manufacturing essentially chemicals, and we do not include firms that ordinarily are considered part of the chemical process industries but whose products are not strictly chemicals (e.g. petroleum refiners, synthetic rubber, glass, and soap manufacturers). This distinction is important, especially when you consider the amount planned for capital expenditures in 1952 is approximately $1½ billion compared with approximately $3¼ billion for the chemical process industries. Expenditures for the atomic energy program, of course, could not be included either as a chemical or a chemical process industry.

In the following comparisons, "All Manufacturing" includes such industries as steel, machinery, electrical machinery, autos, transport equipment, food, petroleum and coal products, textiles, etc.

CAPITAL EXPENDITURES

Chemicals—From an actual expenditure in new plants and facilities of $1,266 million in 1951, planned expenditure for 1952 jumps to $1,464 million. Preliminary plans for 1953, 1954 and 1955 call for $1,323 million, $1,191 million and $1,179 million respectively. This represents a tapering off—but to a level considerably above pre-Korea.

All Manufacturing—Corresponding figures for all manufacturing are $11,141 million for 1951, $12,921 million for 1952, $10,028 million for 1953, $8,525 million for 1954 and $8,194 million for 1955. This represents a 26 percent drop from the 1951 figure for all industry. Note that for chemicals alone the indicated drop is only 7 percent.

The big post-mobilization drop will be in the defense industries—steel, machinery, autos and transport equipment. These companies will turn out lots of defense production after 1952, but they will have largely completed their plant expansion this year. In non-defense lines, the adjustment to lower capital spending will come this year.

Capital spending in chemicals will remain high for two reasons. First, the great surge of expansion generated by the defense program is still gathering momentum. Second, chemical expansion is dictated by growth prospects of the industry.

CAPACITY

Chemicals—Based on index of 1939 = 100, chemical capacity has risen from 172 in January 1946 to 322 in December 1951 for an 87 percent increase.

All Manufacturing—Over the same period, the index for all manufacturing has risen from 131 to 187 for a 43 percent increase.

Planned 1952 capacity for chemicals is 357 by the index or 11 percent over 1951; for all manufacturing it is up to 203 or 8 percent over 1951.

WHAT SPENDING IS FOR

Chemicals—Chemical firms will allocate 78 percent of their 1952 capital expenditures to expansion and only 22 percent of these expenditures to modernization.

All Manufacturing—Manufacturers as a whole will allocate 53 percent of their capital expenditures for expansion in 1952 and 47 percent for modernization.

Difference in the amounts allocated to expansion reflects the fact that the chemical industry is primarily a growth industry, compared with the other manufacturing segments. Higher rate of obsolescence of chemical processes probably accounts for a portion of this difference, however.

WHERE MONEY WILL COME FROM

Chemicals—67 percent of the chemical firms will finance 1952 capital expenditures entirely from profits and reserves, 22 percent will borrow a portion, and 11 percent will sell stock to raise a portion of their required funds.

All Manufacturing—For all manufacturing firms the 1952 figures are 80 percent, 17 percent and 3 percent respectively.

Traditionally chemical firms have financed capital expenditures almost entirely from profits and reserves. Now they lack sufficient profits and reserves to continue doing so, and are falling behind all manufacturing in this respect.

PAY-OFF TIME FOR NEW EQUIPMENT

Chemicals—6 percent of the chemical firms which were covered by the survey are saying new equipment must pay off in 2 years or less, 6 percent in three years or less, 50 percent in 5 years or less and 100 percent in 10 years or less.

All Manufacturing—Figures for all manufacturers are 6, 21, 61, and 97 percent respectively.

More than 40 percent of the companies answering the survey said that it takes longer for an investment in new equipment to pay off than it did two or three years ago. Equipment costs are up, and taxes cut into the additional profit derived from more efficient machines.

WHAT'S BEHIND 1953-55 PLANS?

Chemicals—For the 1953-55 triennium, capital expenditures by chemical firms will be divided 60 percent for more capacity for present products, 60 percent for capacity for new products, 27 percent for plants to serve new market areas and 47 percent for replacement and modernization. (Percents do not add to 100 because most companies gave more than one reason for investment plans.)

All Manufacturing—For all manufacturers, the corresponding figures are 48, 33, 13, and 83 percent respectively.

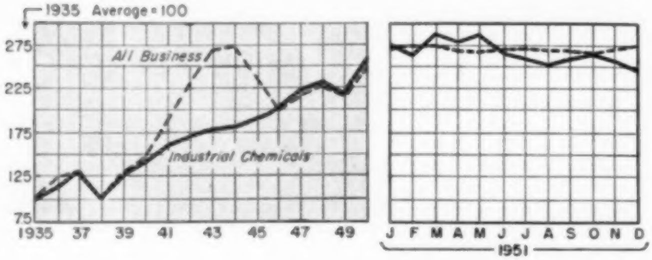
PLANNING HOW FAR AHEAD?

Chemicals—No chemical firms reported they plan capital expenditures more than 5 years ahead, 71 percent reported they planned more than 4 years ahead, 93 percent more than 2 years ahead and 100 percent more than 1 year ahead.

All Manufacturing—Corresponding figures for all manufacturers answering this query were 3, 34, 92 and 100 percent.

Process Industry Trends

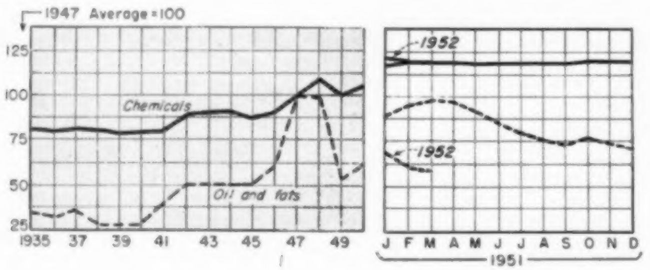
CONSUMPTION



Industrial Chemicals Index

	Jan. (Est.)	Dec. (Prelim.)	Nov. (Revised)
INDEX	250.00	242.14	256.92
Fertilizer		52.63	57.21
Pulp and paper		27.80	29.90
Petroleum refining		26.75	25.96
Iron and steel		16.29	16.13
Rayon		26.78	28.05
Glass		17.81	18.32
Paint and varnish		19.27	23.10
Textiles		9.46	10.93
Coal products		11.47	11.11
Leather		3.62	3.62
Explosives		7.76	9.10
Rubber		5.50	5.92
Plastics		17.80	17.57

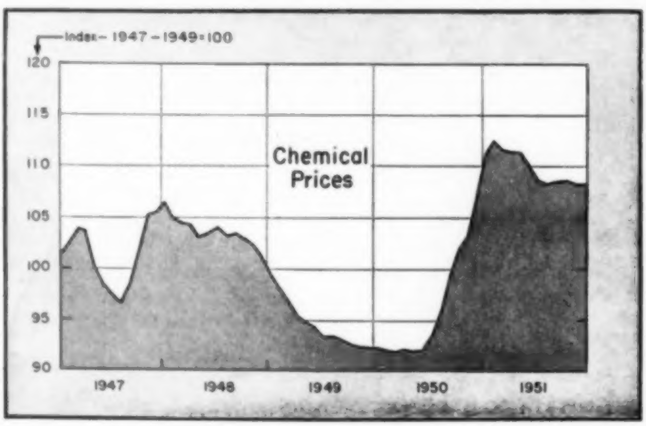
PRICES



Chemical Engineering's Price Indexes

Chemicals – Down –0.02%
Oils and Fats – Down –0.9%

	Chemicals	Oils & Fats
As of Mar. 1, 1952	120.71	61.23
Last month	120.74	61.76
March 1951	118.98	98.69
March 1950	99.84	53.57



After 20 Years, New Wholesale Price Index

We had an unveiling of a sort in New York the last week in February. The Bureau of Labor Statistics, after five years work, has brought out a more up-to-date version of its wholesale price index of chemicals and products.

On February 29, authorities from BLS tried to explain the new index that will mean a lot of things to a lot of people in the chemical business.

First, the base period was pushed up from 1926 (when a few of today's market researchers were no more than a gleam in their father's eye) to 1949. Second, coverage of chemical commodities has breached a hiatus of 23 years, realizing the fact that such things as synthetic fibers, synthetic rubber, synthetic resins and plastics, synthetic drugs and antibiotics—even synthetic faces for the distaff chemists—have come along since the twenties.

In the work of almost doubling the old coverage, bureau statisticians have included products from cosmetics to petrochemicals with a few on either side to round off the alphabet.

The new December index hits a level of 108.4, compared with the new base of 100 averaged from the years '47 through '49.

Actually, going back to '47 and comparing the new index with the old, shows the two to be roughly parallel with changes no more striking than slightly lower dips and higher rises from time to time. BLS blames the discrepancies on the fact that the new includes more highly processed goods.

One too many

Short supply is a happy state of affairs when a woman buys a hat.

In industry, too often it is a sword that hangs over the buyer's head. Executives who order more than 85 per cent of all Multiwall bags overwhelmingly specify* on-schedule delivery as the factor to which they give greatest weight.

Union Multiwalls are shipped from the world's largest pulp-to-container mill.

The pulp from which they are made comes from forests Union owns or manages. Your supply of Union Multiwalls is unlikely ever to be restricted because of raw material shortages.

When and if allocations are necessary, you can count on receiving your fair share.

These are among the reasons why, since World War II, major buyers have given dependable Union so proportionately great an increase in their Multiwall orders.

More so every day . . .

IT'S UNION FOR MULTIWALLS

*August, 1951 research study.

UNION BAG & PAPER CORPORATION • NEW YORK: WOOLWORTH BUILDING • CHICAGO: DAILY NEWS BUILDING

New Construction

	Current Projects		Cumulative 1952	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	....	....	....	$1,400,000
Middle Atlantic	$3,350,000	$380,000	$33,350,000	6,812,000
South	....	1,885,000	153,865,000	32,127,000
Middle West	....	1,000,000	17,900,000	52,950,000
West of Mississippi	147,075,000	35,545,000	325,673,000	132,695,000
Far West	3,319,000	3,000,000	6,319,000	8,445,000
Canada	....	....	87,500,000	12,150,000
Total	$153,744,000	$41,810,000	$624,607,000	$246,579,000

Proposed Work

Ark., El Dorado—Lion Oil Co., El Dorado, plans expansions at its refinery including catalytic cracking unit, alkylation plant. Estimated cost $5,000,000

Ark., Gum Springs—Reynolds Metals Co., Aluminum Div., 2500 S. Third St., Louisville, Ky., plans to construct an aluminum plant here. Estimated cost $30,000,000

N. J., Springfield—Hanovia Chemical & Mfg. Co., 100 Chestnut St., Newark, is having plans prepared by Epple & Seaman, Archts., 901 Broad St., Newark, for 150,000 sq. ft. factory. Estimated cost $1,650,000

N. J., Vineland—Kimble Glass Div. of Owens-Illinois Glass Co., Nicholas Bldg., Toledo, O., plans to construct a furnace and tube alley building here. Holabird, Root & Brugee, 180 N. Wabash Ave., Chicago, Ill., Archts., Estimated cost will exceed $700,000

N. M., Farmington—Imperial Acid Co., Albuquerque, plans to construct a 60 ton per day sulphur plant recovery unit. Graff Engineering & Equipment Co., 3415 Westminster Rd., Dallas, Tex., Cons. Engr. Estimated cost $775,000

Okla., Cushing—Midland Cooperative Wholesale, Cushing, plans to modernize and enlarge its refinery and install catalytic cracking unit. Estimated cost $2,000,000

Pa., Luzerne Mines—Lucerne Coke Co., Indiana, plans to construct a coke screening plant. Heyl & Patterson, 55 Water St., Pittsburgh, Cons. Engrs. Estimated cost $500,000

Pa., McKeesport—Firth Sterling Steel & Carbide Corp., McKeesport, plans to construct a chemical processing plant. Chemical Plants Div. of Blaw-Knox Co., 930 Duquesne Way, Pittsburgh, Engrs. Estimated cost $500,000

Tex., Amarillo—Texas Co., Texas Bldg., Houston, plans to construct an aviation gasoline refinery. Estimated cost $19,750,000

Tex., Fort Worth—Premier Petroleum Co., Mt. Olivet Rd., plans to construct a catalytic cracking refinery unit and polymerization unit. Estimated cost $1,300,000

Tex., Fort Worth—Sid Richardson Carbon Co., Fort Worth Club Bldg., plans to construct carbon black and synthetic rubber units. Estimated cost $2,000,000

Tex., Houston—Reichold Chemicals, Inc., c/o Henry M. Reichold, 601 Woodward Heights, Ferndale, Detroit, Mich., plans to construct chemical plant to manufacture resins and phenol plastic products. Estimated cost $3,250,000

Tex., Orange—E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington, Del., plans to enlarge its plant here to increase production of Polythene. Estimated cost $10,000,000

Tex., Seadrift—Carbide & Carbon Chemicals Div. of Union Carbide & Carbon Corp., Texas City, plans to construct chemical plant on 2800 acre site between Seadrift and Long Mott. Estimated cost $73,000,000

Wash., Vancouver—Carborundum Co., Vancouver, plans to construct an addition to its plant. Estimated cost including equipment, $3,319,000

Contracts Awarded

Calif., Avon—Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo., has awarded the contract for a 250 ton sulphuric acid and phenol plant to Leonard Construction Co., 37 S. Wabash Ave., Chicago, Ill. Estimated cost $3,000,000

Ga., Cartersville—Goodyear Tire & Rubber Co., Cartersville, has awarded the contract for a tire cord plant to Wigton-Abbott Corp., 1225 South Ave., Plainfield, N. J. Estimated cost will exceed $500,000

Ga., Macon—Pittsburgh Plate Glass Co., c/o M. G. Aldridge, 1048 Patterson Ave., Macon, contractor, will construct a warehouse. Estimated cost $85,000

Ky., Louisville—Kentucky Synthetic Rubber Corp., Camp Ground Rd., has awarded the contract for a plant addition to Kaighin & Hughes, 1080 Atlantic Ave., Toledo, O. Estimated cost $300,000

N. J., Plainfield—National Starch Products, Inc., 270 Madison Ave., New York 16, N. Y., has awarded the contract for a 1 story, 65x210 ft. research laboratory to Wigton-Abbott Corp., 1225 South Ave., Plainfield. Estimated cost $130,000

O., Youngstown—Barrett Div. of Allied Chemical & Dye Corp., 2100 Poland Ave., Youngstown, has awarded the contract for rebuilding its tar products plant and installing new equipment to McKinstrie Construction Co., 4612 Woodward Ave., Detroit, Mich. Estimated cost $1,000,000

Okla., Duncan—Sunray Oil Corp., Duncan, has awarded the contract for rebuilding its hydrofluoric acid alkylation unit to Refinery Engineering Co., Wright Bldg., Tulsa. Estimated cost $1,700,000

Pa., Neville Island—Pittsburgh Coke & Chemical Co., Neville Island, Pittsburgh, will alter its glass plant into chemical plant. Work will be done under supervision of Process Industries Engineering Co., 5640 Friendship Ave., Pittsburgh, Engrs. Estimated cost $250,000

Tenn., Columbia—Shea Chemical Corp., Columbia, has awarded the contract for a rotary kiln and two dryer plants to W. P. Heineken, Inc., 50 Broad St., New York, N. Y. Estimated cost will exceed $1,000,000

Tex., Bellaire—Texas Co., Texas Bldg., Houston, has awarded the contract for a 2 story research and producing laboratory to Gulf Construction Co., Inc., Box 661, Houston, at $505,098.

Tex., Corpus Christi—Southwestern Oil & Refining Co., Port and Summers Sts., has awarded the contract for modernizing and enlarging its refinery to Refinery Engineering Co., Wright Bldg., Tulsa, Okla. Estimated cost $850,000

Tex., Corpus Christi—Sunray Oil Corp., Philtower Bldg., Tulsa, Okla., has awarded the contract for an aviation fuels catalytic cracking refinery to The Lummus Co., 385 Madison Ave., New York, N. Y. Estimated cost $10,000,000

Tex., Cuero—Jergins Oil Co. of Texas and Associated Cos., c/o Shell Oil Co., Shell Bldg., Houston, has awarded the contract for a compressor and stripper plant to Olson Bros., 2541 Times St., Houston. Estimated cost $965,000

Tex., Houston—Diamond Alkali Co., 4100 Clinton Dr., has awarded the contract for organic chemical plant unit to Brown & Root, Inc., Box 3, Houston. Estimated cost $1,750,000

Tex., Houston—Shell Chemical Corp., Shell Bldg., will enlarge its ethyl chloride and synthetic glycerine plants. Work will be done by owners with subcontracts. Estimated cost $1,685,000

Tex., Midland—Phillips Petroleum Co., Bartlesville, Okla., will construct a natural gas plant. Work will be done by owners. Estimated cost $5,500,000

Tex., Port Arthur—Gulf Oil Corp., Port Arthur, has awarded the contract for a sulphur plant to extract sulphur from waste refinery fumes, also sulphuric acid plant, to Leonard Construction Co., 37 S. Wabash St., Chicago, Ill.; acid sludge decomposition plant and polymerization unit for manufacturing high octane gasoline to Bechtel Corp., 220 Bush St., San Franciso. Estimated cost $4,000,000

Tex., Smiths Bluff—Pure Oil Co., Smiths Bluff, has awarded the contract for 26,000 bbl. refinery expansion consisting of fluid catalytic cracking unit, polymerization and auxiliary processing units, also 20,000 bbl. vacuum-flash refinery unit to M. W. Kellogg Co., Esperson Bldg., Houston. Estimated cost $5,200,000

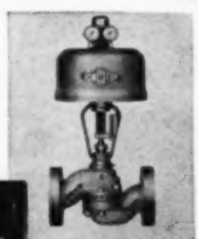
Tex., Texas City—Carbide & Carbon Chemicals Div. of Union Carbide & Carbon Corp., Texas City, will construct a butadiene unit. Work will be done by owners with subcontracts. Estimated cost $525,000

Tex., Texas City—Texas City Refining Co., Texas City, has awarded the contract for modernizing existing refinery units, new refinery, storage and shop units to Henry Kaiser Engineers, c/o Owners. Estimated cost $2,865,000

Cut CONTROL VALVE MAINTENANCE COSTS!

For inspection and maintenance Annin Valves remain in the line

The single seat design of the Annin valve body means lower maintenance costs. As shown, the lower half separates from the valve assembly, exposing for inspection or replacement the valve seat, plug and stem—without removing valve from line. No special pipeline crews are necessary. On-the-job inspection and maintenance by plant crews is practical and economical. Valve seat is not threaded and can be replaced without special tools or grinding-in operations. Under severe erosive and corrosive conditions lower half can be easily replaced at small cost compared to total valve investment. This cost-cutting feature applies to *all* Annin Valves—Domotor, Solenoid, and Handwheel types. All give the ultimate in precision *positive* control. If you are interested in lower maintenance, *and* operating advantages approached by *no other valve*—it will pay you to investigate Annin Valves.



The Annin Domotor valves provide positive control of corrosive, erosive fluids and fluids containing semi-solids.

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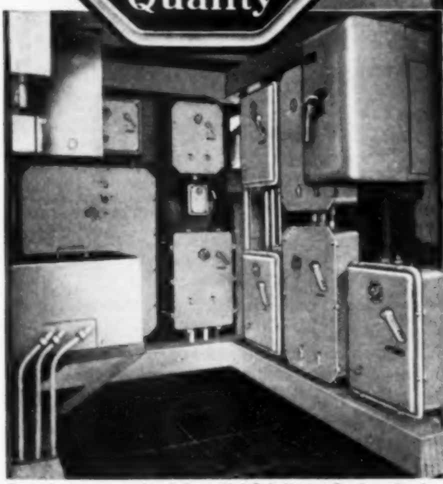
ANNIN CONTROL VALVES

THE ANNIN COMPANY

String of refrigeration cars being bunker-iced by a Link-Belt Master Car Icer operated by Allen-Bradley controls.

A-B Quality



Typical motor control unit for a Link-Belt Master Car Icer showing the many Allen-Bradley solenoid controls in watertight enclosures.

Link-Belt Master Car Icer

operated by

Allen-Bradley Controls

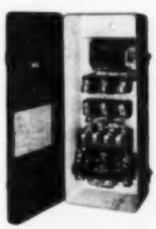
To insure scheduled car icing in a minimum of time requires rugged, quality equipment. Allen-Bradley motor controls play an important role because they are so reliable and trouble free.

The selection of Allen-Bradley solenoid starters for your equipment is always a wise choice. Their simple design guarantees millions of trouble free operations. Furthermore, their double break, silver alloy contacts require no maintenance. Allen-Bradley thermal overload relays are dependable and remain accurate in their operation, even after long service.

See the nearest Allen-Bradley control engineer for recommendations regarding your motor control problems. He will be glad to assist you.

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.

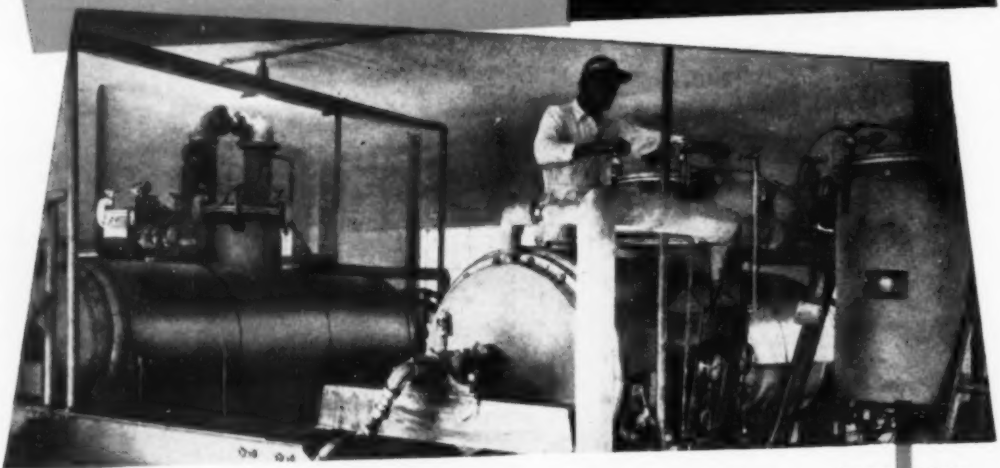
Bulletin 712 Combination Starter with front-operated disconnect switch with fuse clips in the NEMA Type 1 general purpose enclosure. Generous wiring room. Bonderized.



Bulletin 712 Combination Starter in the NEMA Type 4 watertight and weathertight enclosure. Rubber gasket seal. Reliable overload protection provided.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

Keep it out of the air... ...Process in Vacuum



Installation of Stokes Rotary Vacuum Dryers used by Metals Disintegrating Co., Berkeley, Cal., for drying of aluminum powder.

Many powdery oxidizable materials, such as aluminum when dried in powdered form, tend to ignite in the presence of air and burn with explosive effect.

Many heat-sensitive chemicals suffer serious impairment of their properties when dried under atmospheric conditions.

Many products, such as blood plasma, are completely deprived of their original values through atmospheric drying.

In contrast, these same materials, when dried under vacuum, are free from fire and explosion hazards, free from chemical change and deterioration; and, as a bonus, valuable solvents are fully recoverable.

Vacuum drying can be done at temperatures well below 100°F., causing rapid elimination of excess moisture, without affecting the chemical properties of the product. Drying speed is increased; drying time and overhead are reduced. Finished products have low and uniform moisture content. Valuable solvents are easily recovered at 99% efficiency, or better.

A new 24-page brochure, just off the press, entitled "Vacuum Drying," explains the wide range of processes and equipment by which chemicals are dried under vacuum. Many typical vacuum drying problems and their solutions are included. Send for a copy.

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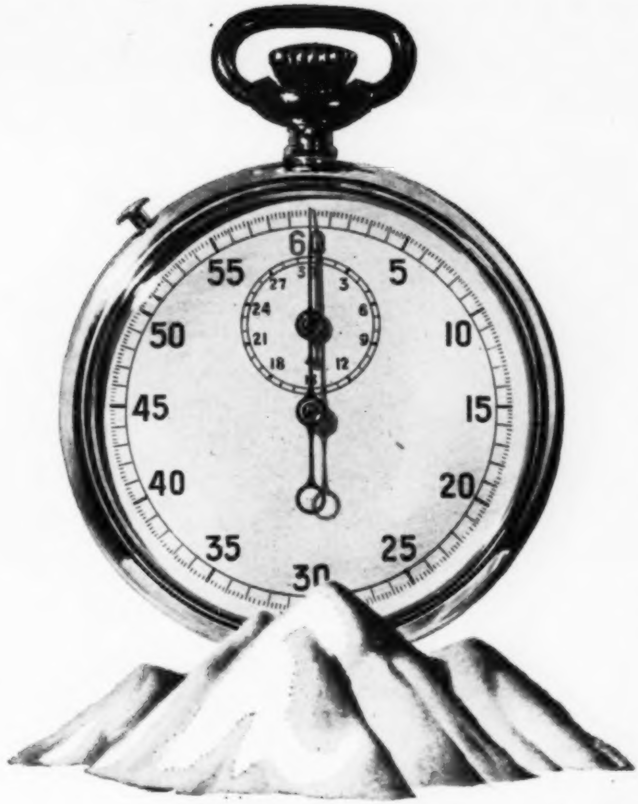

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You can also expect prompt service from Kaiser Chemicals' engineers—men who have spent years in solving the problems connected with the manufacture of abrasives, glass, ceramics, refractories, catalysts, chemicals for water treatment.

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STERLING SLO-SPEED!

Mr. M. Cinaman of Crown Machinery and Equipment Sales Co., Los Angeles, states that Slo-Speeds are the ideal drives for their paste mixers because of Slo-Speed's compact design which saves 10% in mounting space and enables design of a mixer that accommodates motors from 5 to 15 H.P., and because of Slo-Speed's quiet operation, versatile mounting, low maintenance and positive oil seals.

STERLING SLO-SPEED GIVES YOU THE ONE BEST LOW SPEED AND

gives uninterrupted service—carries heavy overhung loads—provides versatile mounting and flexibility in arrangement of machinery—saves valuable space—provides greater safety—costs less to install and use. An indispensable source of low speed power for:

Agitators	**Dryers**	**Presses**
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- STERLING SPEED-TROL (VARIABLE SPEED) MOTORS
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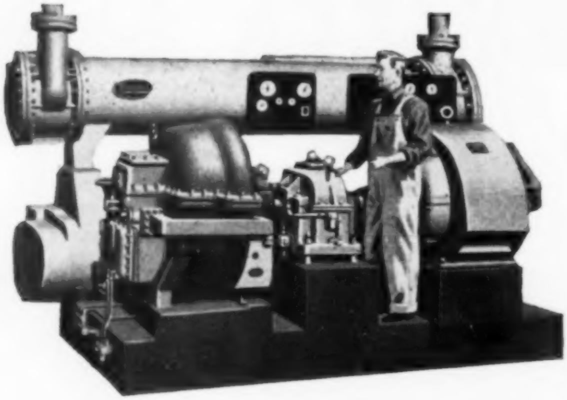
STERLING ELECTRIC MOTORS

Plants: New York City 51; Van Wert, Ohio; Los Angeles 22; Hamilton, Canada; Santiago, Chile.
Offices and distributors in all principal cities.



Anybody got a match?

Here's a flat statement about the Carrier Centrifugal Refrigerating Machine. *It has no match in its field.*

After all, we've been making multi-stage centrifugals for thirty years now. We've made more of them than anyone else—some 2500 of them, in fact. And we back up each one with the largest, most experienced national service organization in the business.

The Carrier Centrifugal Refrigerating Machine is a compact unit that will bring temperatures down to minus 125°F. and even lower if you want it to. It directly condenses ammonia, chlorine and other gases, and it's available in a complete range of sizes all the way up to 2500 tons capacity.

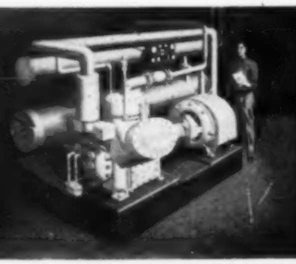
Lots of design advantages, too. The finest shaft seal the industry has ever seen is in the Carrier Centrifugal Refrigerating Machine—an automatic, all-metal, non-friction oil seal. The machine installs easily on simple foundations and has the smallest dimensions per ton of capacity of any centrifugal you can buy.

Who can match that?

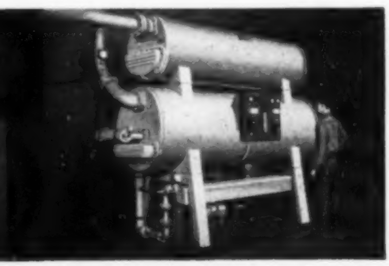
There's a lot more we'd like to tell you, so we're offering an informative catalog on "Centrifugal Refrigeration." Write for it to Carrier Corporation, Syracuse 1, New York.

Carrier

AIR CONDITIONING
REFRIGERATION
INDUSTRIAL HEATING



If your needs are best met with reciprocating type equipment, your best choice is this Carrier Reciprocating Refrigerating Machine in a compact package.



If you have high or low pressure steam available, investigate the exclusive Carrier Absorption Refrigerating Machine—lightweight, has no moving parts.

Three

waste water problems solved by

GRAVER REACTIVATOR

Here was a particularly difficult problem of high solids in waste water in a large eastern process plant.

This waste water contains up to 1500 ppm of suspended solids and 3000 gpm were to be treated. The problems were:

(1) to prevent stream pollution,

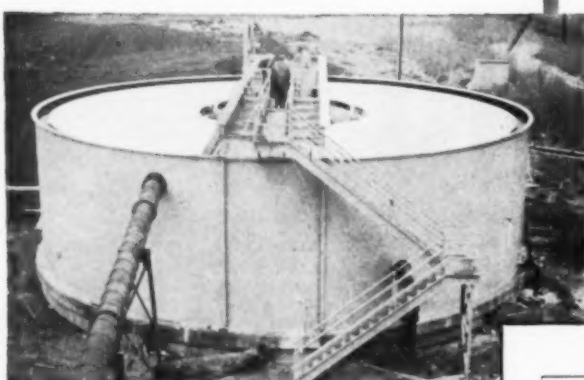
(2) to produce solids of the highest concentration for disposal,

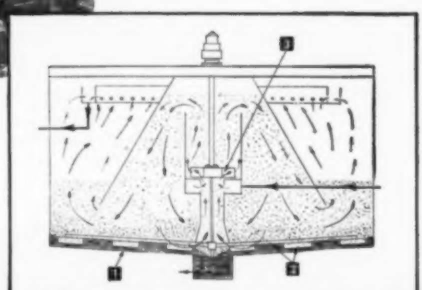
(3) to recover clear water for process use.

A Graver Reactivator was selected to solve this multiple problem. The Reactivator is doing the job so effectively that it delivers solids up to 14% by weight while producing an effluent suitably clear for recycling in the system, *without any chemical treatment.*

In plants all over the country, Graver Reactivators are effectively and economically treating raw water supplies and conditioning waste waters for reuse or for trouble-free disposal. These units can solve *your* liquid conditioning problem, too. Their distinctive design is described in Bulletin WC-103.

Write today for a copy and for free technical paper, "Some Economic Factors in Waste Water Treatment".





Three exclusive Graver Reactivator Features

1. *Full bottom area for solids concentration and collection.*
2. *Separately driven highly efficient sludge scraper and blades.*
3. *Positive and intimate contact of incoming water with sludge by variable speed sludge recirculation impeller.*

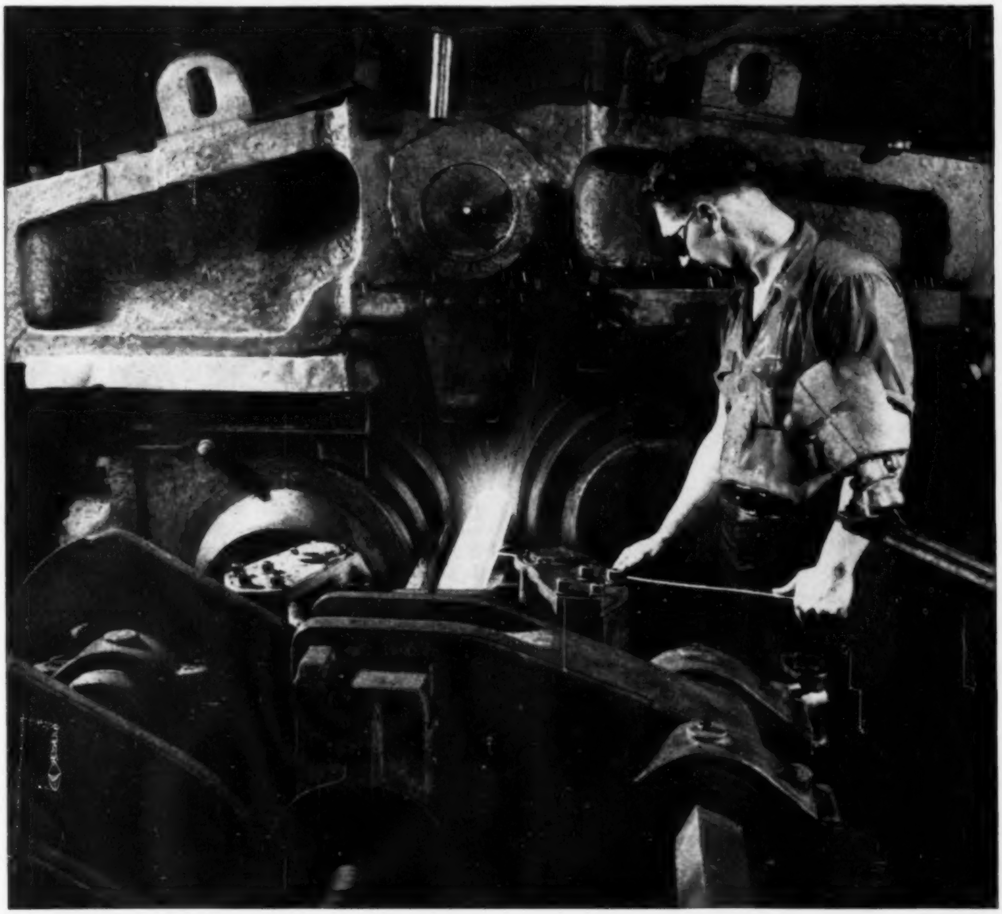
GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

216 WEST 14th STREET, NEW YORK 11, N. Y.

GRAVER

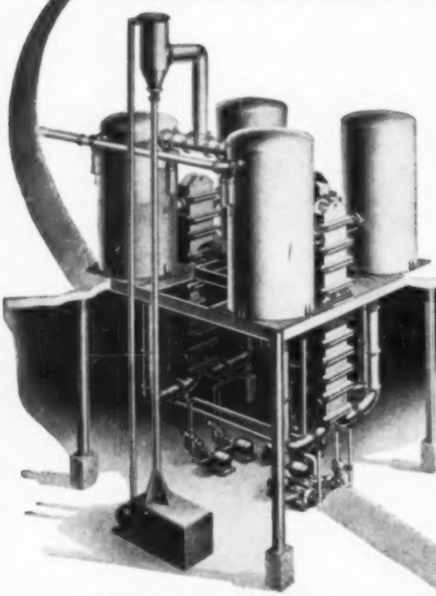
GW 498



Conkey Flat Plate Evaporators with Rosenblad Switching System*

Completely self-cleaning during operation

No down time! No scale removal costs!



Conkey 4-Body Triple Effect Flat Plate Heating Surface Evaporator

Take a leaf from the flow sheets of another industry. For years evaporation of spent sulphite pulp cooking liquors in sulphite pulp manufacture was considered highly impractical because a gypsum coating developed on heating surfaces. But today—it can be a *continuous, full capacity self-cleaning operation* through use of Conkey Evaporators and Rosenblad Channel Switching System.

The advantages of the Rosenblad Channel Switching System have been thoroughly proven both in this country and abroad. Heating surfaces, interconnecting pipe and pump systems *are completely cleaned during normal operation!* It's especially effective wherever lime salts scale evaporators.

Conkey equipment adapts itself well to channel switching for self-cleaning operation while providing all the other advantages of multiple effect evaporation: forced circulation . . . falling film . . . recompression . . . thermal compression . . . high vacuum and other specialized benefits where required.

*Patents Applied For

PROCESS EQUIPMENT DIVISION
GENERAL AMERICAN
TRADE MARK

PROCESS EQUIPMENT DIVISION
GENERAL AMERICAN
TRANSPORTATION CORPORATION

Sales Offices: 10 East 49th Street, New York 17, New York
General Offices: 135 South LaSalle Street, Chicago 90, Illinois

Sole licensee in the U. S. A. for the
A. B. Rosenblads Patenter Evaporator Switching System.

OFFICES IN ALL PRINCIPAL CITIES

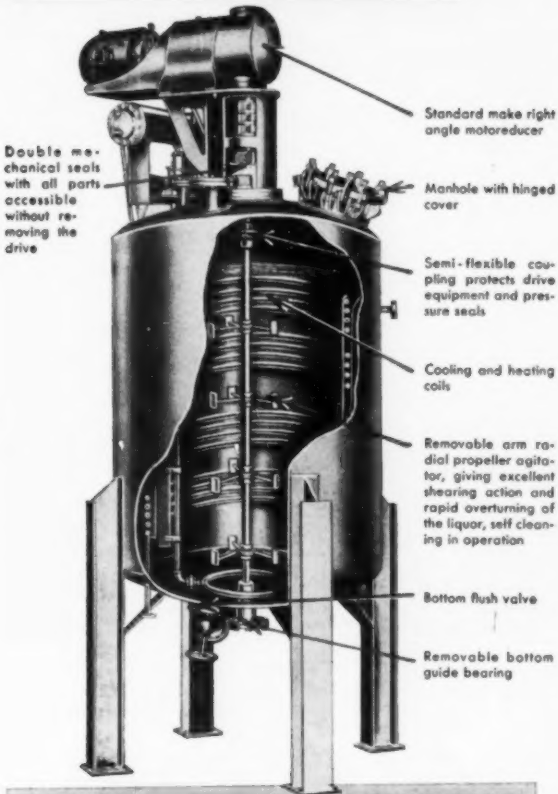
GET THE FULL DETAILS. Write today for new bulletin. See how a Conkey Evaporator with Rosenblad Switching System can eliminate down time, eliminate scale removal costs and keep a constant flow sheet for you.

Other General American Equipment: Turbo-Mixers, Filters, Dewaterers, Dryers, Towers, Tanks, Bins, Pressure Vessels.

NOW! The Struthers Wells Hydrogenator

featuring

Advanced Agitator Design for Quick and Thorough Dispersion of Gases and Solids



The agitators, supporting structure, agitator shaft seals and drive incorporated in the new Struthers Wells Hydrogenator have been carefully designed to give maximum efficiency and long trouble-free service in dispersing gases and catalysts under normal or extreme conditions of temperature and pressure.

The diagrammatic illustration at the left shows how the agitator shaft is independently supported at two points within the vessel. Note how the radial propeller agitators are mounted in multiple on the shaft dividing the overturning of the content into several strata. The coils are carefully located to provide minimum obstruction to proper agitation and the flush outlet valve eliminates a pocket into which the catalyst might accumulate. This type of equipment is ordinarily made of stainless, nickel, monel, inconel or mild steel and individually designed to operate under specific conditions of pressure, vacuum, temperature and degree of agitation.

RADIAL PROPELLER AGITATOR

Because of its high peripheral blade speed and the rapid overturning and turbulent motion it imparts to the liquor, the radial propeller effectively disperses and entrains both the hydrogen and catalyst within the liquors to be treated thereby creating the optimum condition necessary to a maximum absorption and reaction. The removable arm feature provides inexpensive adjustment of the degree and type of agitation which might be necessary due to change of process or operating conditions.

Write for Complete Data

Struthers Wells

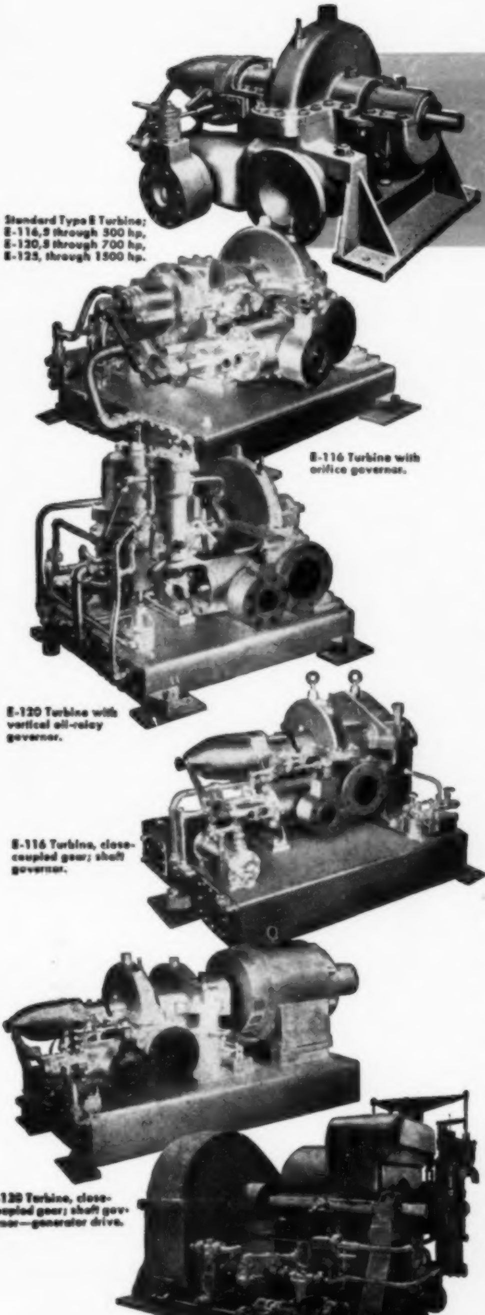
STRUTHERS WELLS CORPORATION

Process Equipment Division . . . Warren, Pa.

PLANTS AT WARREN, PA. • TITUSVILLE, PA.

Offices in Principal Cities

Take the *Guesswork* out of Turbine Selection!



Standard Type E Turbine; E-116, 5 through 500 hp, E-120, 5 through 700 hp, E-125, through 1500 hp.

E-116 Turbine with orifice governor.

E-120 Turbine with vertical oil-relay governor.

E-116 Turbine, close-coupled gear; shaft governor.

E-120 Turbine, close-coupled gear; shaft governor—generator drive.

M-28 Turbine, flexibly coupled, double-ended, paper-machine drive.

Westinghouse General-Purpose Turbines can be supplied for mechanical or generator drive . . . either direct connected or geared . . . for condensing or noncondensing operation. This *complete* line . . . plus a nationwide staff of trained steam engineers, conveniently located sales offices, and service shops . . . assures you of the correct solution to *your* steam-drive application problem.

The single-stage Type E turbine, with designs for three basic classes of steam conditions, three wheel sizes and three standard governor types, provides in effect twenty-seven *standard, economical* variations to cover a wide range of applications. In addition, an almost limitless number of special applications can be met through the use of heavy-duty parts, and optional accessories.

Geared-turbine drives are offered either flexibly coupled to accommodate either right- or left-hand gear offsets, double-ended output shafts; or close-coupled (Gearturbines). Gearturbines are standardized on a single offset arrangement, affording utmost economy.

Other types in the complete Westinghouse general-purpose turbine line include heavy-duty and multi-stage units for applications requiring high temperatures and pressures, higher speeds, greater horsepower, extraction for process applications, or higher efficiency than may be had with single-stage machines.

The superiority of the Westinghouse line is the result of over 60-years' design, manufacture, and application experience. To get the benefit of this broad know-how, call your nearby Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-30532

YOU CAN BE SURE... IF IT'S

Westinghouse

GENERAL-PURPOSE TURBINES


9
8
7
6
5
4
3
2
1
0
every speed with Varidrive
You simply turn a control handle! Instantly the speed of the Varidrive changes to the exact rpm you need. The productive scope of your powered machines and equipment will be greatly increased. Your operators can produce more output every hour.
U.S. Varidrive Motors

FOR THOSE EXTREMELY CORROSIVE CONDITIONS...
CONSIDER THE USE OF *Amer-Plate*

Available in Two Convenient Types To Meet Your Needs

Plain AMER-PLATE for existing steel or concrete tanks or structures
Plain Amer-Plate is smooth and flat on both sides. It is applied to existing surfaces using specially developed cements that provide a firm bond with those surfaces.

T-LOCK AMER-PLATE for newly cast concrete pipe and structures
T-shaped parallel "anchors" are an integral part and extend along the back of each Amer-Plate sheet. The sheet is applied to the inner forms of tanks, concrete pipe, and structures. When the concrete is poured, the tees are embedded and locked into the concrete.

HERE'S A NEW, EXTRA-TOUGH, ECONOMICAL INDUSTRIAL SHEET LINING

Especially designed to protect against extremely corrosive conditions, Amer-Plate is particularly adaptable for use in highly corrosive sewers, chemical storage tanks, tank cars and tank trucks hauling unusually corrosive solutions.

Composed of inert resins and plasticizers, Amer-Plate is impervious to gases, highly resistant to acids, alkalies, alcohol, oils, salts, and petroleum products. It has a very low moisture vapor transmission rate, will not support combustion, and contains no toxic materials.

Amer-Plate is a flexible thermoplastic sheet, practical for application to flat, curved and angular surfaces. Its economy and effectiveness has been proved in the field in over 10 years of development and testing.

So... wherever you require long lasting protection against extreme corrosion, make a full investigation of the possibility of using Amer-Plate. Write for complete information.

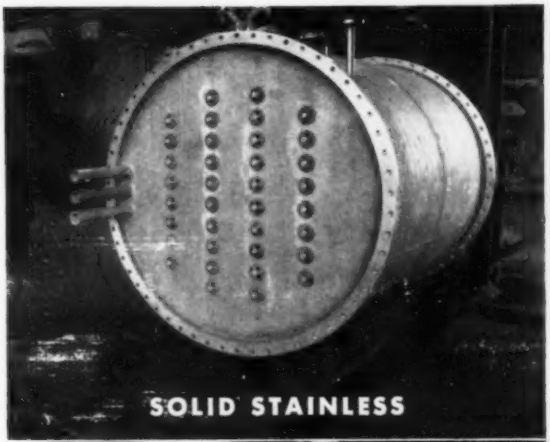
Amer-Plate industrial sheet lining is the result of many years experience in the manufacture and application of Amercoat protective coatings.

AMERCOAT CORPORATION

A division of American Pipe and Construction Co.

4809 Firestone Blvd., South Gate, California


Line Up With
CHAPMAN
for all Types and Sizes of Cast Steel
Gate, Globe and Check Valves
Yes, Chapman makes cast steel gate, globe and check valves, to ASA and API ratings . . . for all pressures and purposes and in all sizes.
So file this mental note: It pays to check with Chapman on all your valve requirements, standard or special. Have you the latest edition of Catalog 20 covering Cast Steel Valves? It's yours for the asking.
The CHAPMAN VALVE Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS



SOLID STAINLESS

STAINLESS-CLAD

GRAVER TOWERS

IN STEEL AND ALLOYS FOR EVERY PROCESS REQUIREMENT

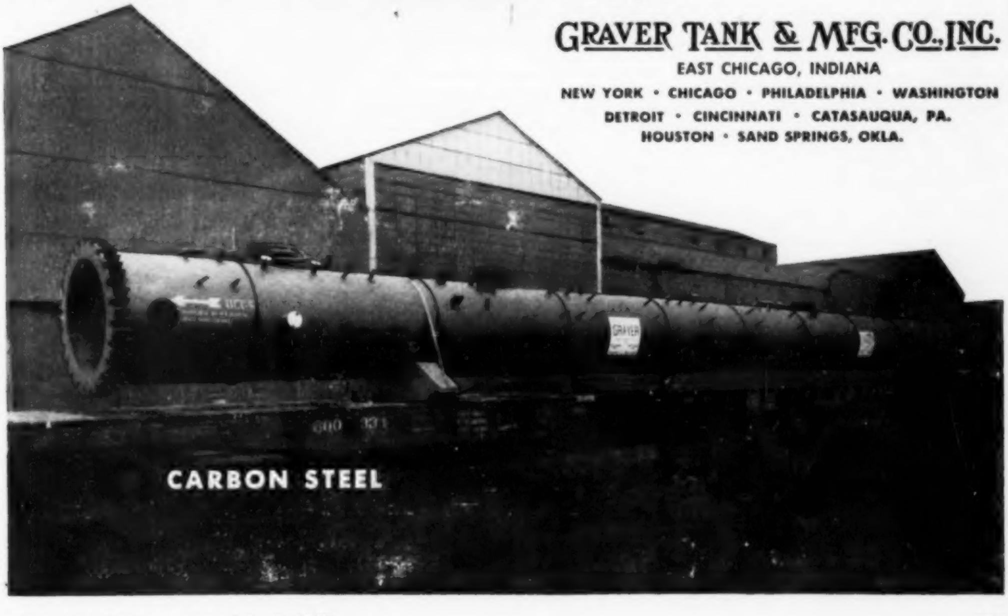
Here are excellent examples of Graver's ability to satisfy the diverse requirements of the petroleum and process industries. Fabricated to conform with standard codes or special requirements, these towers are the result of Graver's long experience in manufacturing quality vessels in steels, clads and alloys.

The wide variety of processing plants in which these intricately designed towers and columns are operating today attests to Graver's versatile craftsmanship and indicates why Graver has long been a prime source of supply in this exacting field.

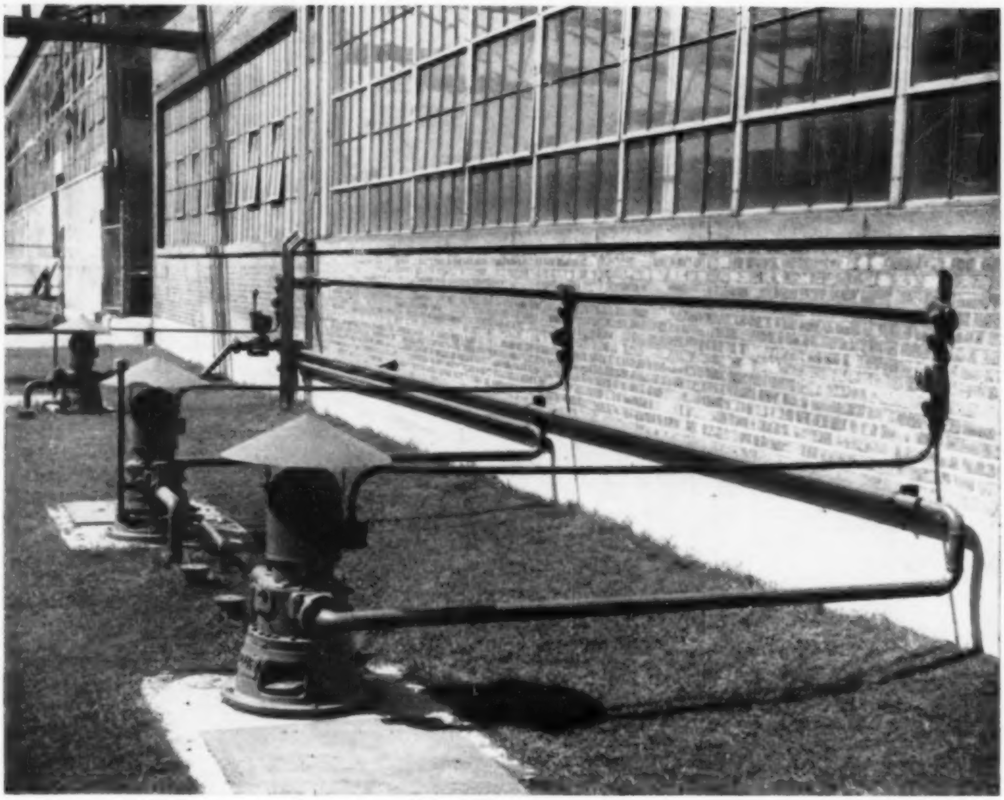
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK · CHICAGO · PHILADELPHIA · WASHINGTON
DETROIT · CINCINNATI · CATASAUQUA, PA.
HOUSTON · SAND SPRINGS, OKLA.



CARBON STEEL



Have you a tougher pumping job than this?

These pumps — regular La Bour Type BGM with the housings sealed and equipped with explosion-proof motors — are handling alcohol-acetone mixtures under a 13 foot suction lift and against an 85 foot head. The presence of this solvent would make packing lubrication extremely difficult — but all LaBour Type G pumps are packingless, so there's no problem at all.

The volatility of the alcohol-acetone solution demands a truly self-priming pump that cannot vapor bind—and of course that's LaBour. (Notice the sunshades to keep off hot rays which would induce greater vaporization.) The housings are sealed and vented through pipes and air-release valves on account of the fire hazard.

Here is another instance that proves LaBour pumps are the answer to the tough pumping jobs. That's why they can be counted on for *dependable* service on *any* job.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LaBOUR

THE LaBOUR COMPANY, INC. • Elkhart, Indiana, U.S.A.

Get

something extra

when you buy

lead valves

Do you look for sturdiness, dependability, and suitability in the lead valves you buy?

Do you expect valve type, size pattern and flanging to meet your acid handling equipment specifications?

Of course you do! And when you order National you *get* what you look for. You *get* what you expect. And you get certain "extras" besides . . . extras that spell highest quality.

For example, National Lead valves have precision, lathe-turned stems. They have full flow-ways. They're designed to permit repacking in service. And they have positive plug-seat fit.

Fabrication extras . . . design extras . . . quality extras . . . Yes! And these extras you get, but never need specify, add up to outstanding service on the job.

That's why it pays to buy National valves . . . for something extra in lead.

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited)

*Reg. U. S. Pat. Off.

Lead valves

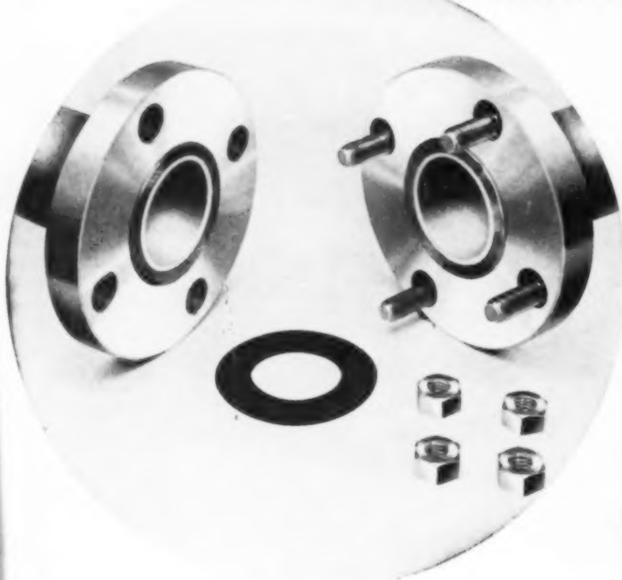
with a NATIONAL reputation

LEAD COMPANY

New corrosion-resistant fittings

reduce assembly time

reduce piping costs, too!



Speedline aligning connector

Joins pipe schedules 5, 10 and 40. Also made for use with tubing.

Speedline insert flange

Corrosion-resistant serrated insert in a carbon steel flange. Only tools needed for assembly are a standard expander and open-end wrench.

Speedline tube union

Combines best features of screwed pipe and sanitary unions; eliminates leakage encountered with ground joint type fittings.

• Fast, low-cost installation of light-wall, corrosion-resistant lines is now possible with *Speedline* Fittings. Exclusive design of flange, for example, eliminates need for welding or flaring. Joints are tight and leakproof . . . a big improvement over other types of fittings.

The cost of *Speedline* Fittings is surprisingly low. And because you can use light weight Schedule 5 pipe or tubing, your piping costs are reduced by as much as 40%. As one engineer says: "We started to use *Speedline* Fittings with Schedule 5 pipe to save money. Now we find that we also get better flow conditions and increased capacity in our lines."

To learn more about this way to improve process piping layouts—at a lower cost than you have been paying, ask for a copy of the *Speedline* Fittings book.

Book Shows How to Save Money —Even Under Today's Conditions

Just write a note on your company letterhead and we will mail the *Speedline* book to you. It shows *why* you get better results at less cost with *Speedline* Fittings.

Speedline **Corrosion-Resistant FITTINGS**

—the newest thing in pipeline economy

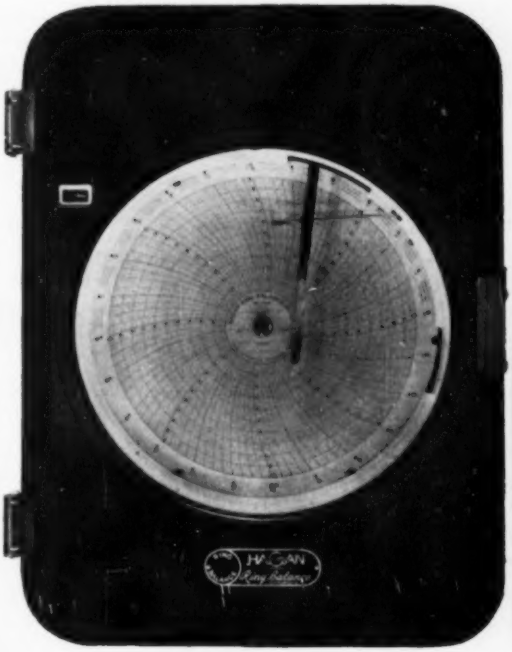
HORACE T. POTTS CO. *Since 1815* Erie Avenue & D Street · Philadelphia 34, Pa.

use dependable HAGAN

Ring Balance Flow Meters

to measure flow of

water–gas–steam–oil–air–other fluids



There are many reasons why you get dependable records when you use Hagan Ring Balance Flow Meters.

These include the unique ring torque resistance system which not only makes it possible to meter low flows reliably, but also provides an integral and convenient means for altering the meter capacity to any value over a 3½ to 1 range. Range changing is further simplified by a dead weight method of calibration. Other features include:

- No stuffing boxes
- Adjustable full scale range
- High sensitivity at low flow rates
- Mercury level not critical

Dependable pressure and temperature compensation (either or both) can be furnished with all Hagan Ring Balance Flow Meters.

An economical feature of all Hagan Ring Balance Meters is that maintenance costs are low. For other information on how versatile Hagan Ring Balance Flow Meters will answer your metering problems, clip the coupon, or write.

HAGAN CORPORATION

HAGAN BUILDING
PITTSBURGH 30, PA.

Ring Balance Flow and Pressure Instruments
ThrusTorq Force Measuring Devices
Boiler Combustion Control Systems
Metallurgical Furnace Control Systems

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters.

I am particularly interested in ....

....

NAME ....

POSITION ....

COMPANY ....

STREET AND NUMBER ....

CITY .... ZONE .... STATE ....

STURTEVANT

Dustless BLENDERS

Produce Perfectly Mixed Products with NO Loss of Materials

RECEIVING

The ingredients to be mixed enter the mixing chamber of the drum through a chute. Note scoops which carry up and dump the ingredients as the drum rotates.

DISCHARGING

By simply throwing a lever, the inlet is closed and the mixer is in discharging position. The completely mixed materials drop off the lifting scoops and discharge through chute without segregation of ingredients

Four-way mixing action produces homogeneous blends. No matter what the densities, weights, finenesses or other physical properties of the ingredients, Sturtevant Dustless Blenders provide *a thoroughly blended product* with no substances floating to remain unmixed. Sturtevant advantages include—single opening for both receiving and discharging . . . "open door" accessibility for quick, thorough cleaning . . . rugged construction for long life and minimum maintenance. Sturtevant Dustless Blenders are available in mixing capacities from 500 to 20,000 pounds. Write for information or engineering assistance.

STURTEVANT MILL COMPANY
100 CLAYTON STREET, BOSTON 22, MASS.

Designers and Manufacturers of

CRUSHERS • GRINDERS • SEPARATORS • CONVEYORS
MECHANICAL DENS and EXCAVATORS • ELEVATORS • MIXERS

BUILDING A GREATER AMERICA

Advance Guard

OR LOOKING AHEAD

Officially, there's no "Travel Bureau" to plan for the safety and comfort of "passengers" like fractionating towers, but Sun Ship workers must plan routes with expert care.

The man who built, in his cellar, a boat too big to go out the window, just didn't look ahead.

The industry that builds a fractionating tower more than 126 feet in length . . . 12 feet inside diameter . . . and weighing more than 180 tons . . . just has to know how to meet the problems of delivering it. Every problem that might be met along hundreds of miles of railway has to be known and planned for.

Knowing clearances and curves, on every foot of railway routes is part of the job. Planning to meet and master those problems, or to select routes which eliminate them, is part of Sun Ship's job when it builds chemical and refinery equipment.

The Sun-built refineries and chemical equipment serving in every part of America and in many foreign lands shows how well Sun men and management have mastered the problems of delivering the equipment they have produced in helping build a greater America.

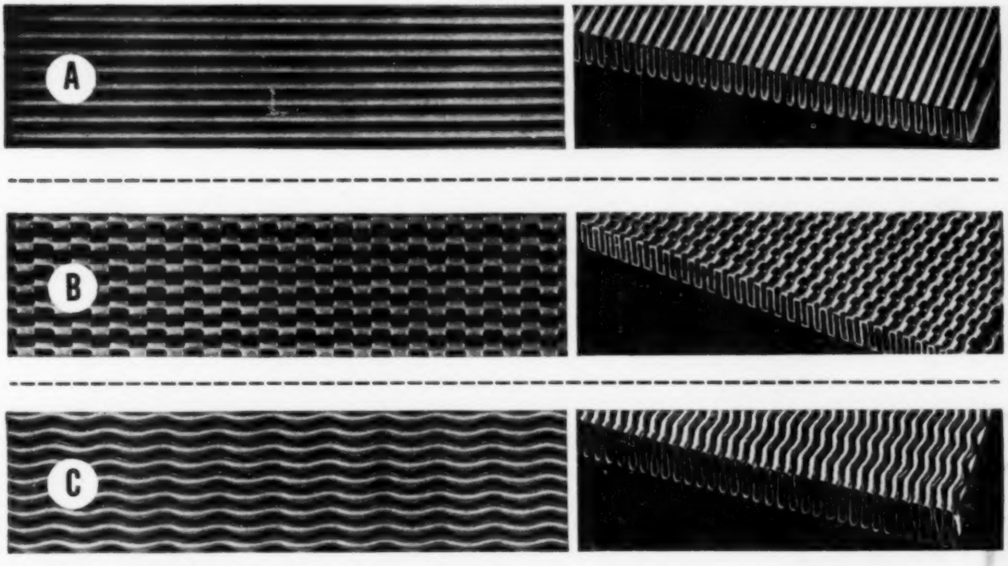
Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY



Three of the many types of fin section available.

TRANE Brazed Aluminum Heat Exchangers Offer Wide Choice of Heat Transfer Surfaces for Greater Design Flexibility

With Trane Brazed Aluminum Heat Exchangers, you choose from a great variety of surfaces in solving exactly your heat transfer problems. They may be straight and continuous (A). They may be serrated (B). Or they can be of herringbone design (C). With these basic designs, exactly the right surface can be selected to provide the correct ratio of heat transfer to pressure drop characteristics.

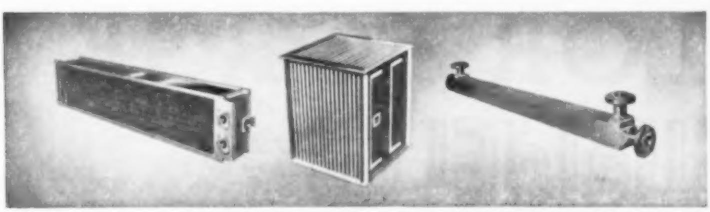
Many further variations of these general types are practical. The height and the thickness of the fin can be varied. So can the number of fins per inch. In fact, fins with entirely different patterns, heights and number of corrugations per inch can be used side-by-side to handle different fluids in the same exchanger.

Thanks to this great flexibility you can provide just the heat transfer, just the pressure drop volume, velocity number and direction of passes you want with Trane Brazed Aluminum Heat Exchangers.

Design flexibility is but one of the many advantages of Trane Brazed Aluminum Heat Exchangers. Compared to conventional exchangers, they produce more heat transfer efficiency in ¼ the space with ⅓ the weight at approximately ½ the cost.

These all-aluminum heat exchangers are rugged, too. They take test pressures up to 1,000 pounds per square inch and temperatures from −300° to 500° F.

Whether the job calls for high or low temperatures or pressures, one stream or many, Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your Trane sales office or write direct.


Here are a few of the many varieties of Trane Brazed Aluminum Heat Exchangers which are now in actual service: 1) A cross flow unit for liquid-to-gas exchange used for condensing purposes. 2) A cross flow gas-to-gas unit which is used for intercooling for aircraft engines. 3) A counter flow liquid-to-liquid exchanger for high pressure application.

TRANE

MANUFACTURING ENGINEERS
OF HEATING, VENTILATING AND
AIR CONDITIONING EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS.
Eastern Mfg. Division . . . Scranton, Pennsylvania
Trane Company of Canada, Ltd. . . . Toronto

OFFICES IN 80 U. S.
AND 14 CANADIAN C

Sulphur

Thousands of tons mined daily, but where does it all go?

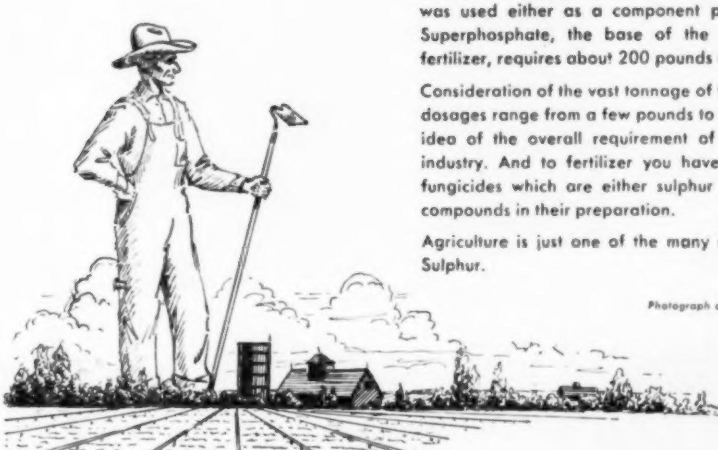
THE DEPARTMENT OF AGRICULTURE reports that in 1950 some 336,000,000 acres of land in the United States were under crop cultivation. That's a lot of acreage.

But where, you might ask, is the connection with Sulphur? Fertilizer, to take just one phase of agriculturally-used chemicals in which Sulphur was used either as a component part or as a processing element! Superphosphate, the base of the most widely used manufactured fertilizer, requires about 200 pounds of Sulphur for every ton produced.

Consideration of the vast tonnage of fertilizer used in agriculture — and dosages range from a few pounds to a ton or more per acre — gives an idea of the overall requirement of Sulphur for this one division of industry. And to fertilizer you have to add all the insecticides and fungicides which are either sulphur derivatives or have used sulphur compounds in their preparation.

Agriculture is just one of the many destinations of great tonnages of Sulphur.

Photograph above shows our loading dock at Galveston, Texas



Texas Gulf Sulphur Co.

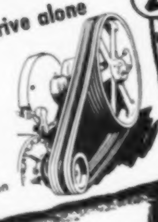
75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

What do you do when your v-belts get loose or break?

1 **Leave the drive alone**

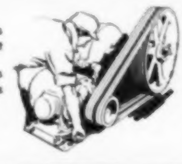
You get more slippage
. . . wasted power
. . . excessive belt wear
. . . uneven sheave wear
. . . less production



2 **Slide the motor back**

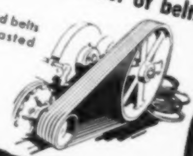
Tight belts get too tight

Life of belts and bearings is reduced

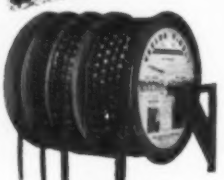


3 **Install a new set of belts**

Discarded belts mean wasted money

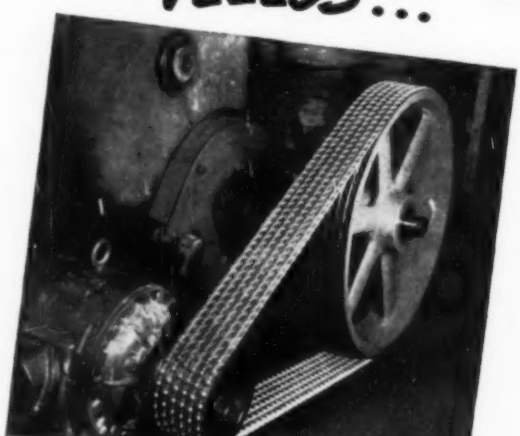


4 **Use VEELOS . . .**



Only with VEELOS . . .

the adjustable v-belt—can you get *all* these operating advantages. And *only* with Veelos can you eliminate costly v-belt inventory because just four reels of Veelos in the O, A, B and C widths can replace up to 316 different sizes of endless v-belts.



Link construction permits quick installation
Easy adjustability
. . . provides controlled tension on each belt
. . . eliminates loafers
Keeps your machines running for profitable production

VEELOS DATA BOOK . . .

The plain facts on construction, installation and use of Veelos are included in this illustrated Data Book—write for your copy.

MANHEIM MANUFACTURING & BELTING COMPANY
602 Manbel St., Manheim, Pa.

VEELOS THE LINK V-BELT

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

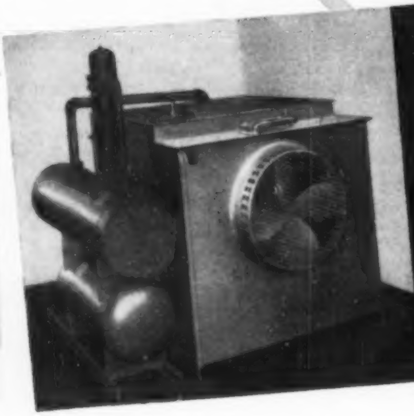
Made in all widths in three types: regular, oil-proof, static conducting. Also double V in O, A and B. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 350 distributors throughout the country. VEELOS is known as VEELINK outside the United States.


Don't shoot
the piano player
he's doing the
best he can
Gene
Sharp

New

Illustrations show two views of a 35 ton Condenser Tower prior to partial disassembly for shipment.

SAVES WATER and CUTS MAINTENANCE COSTS . . .



Vogt
CONDENSER TOWER
FOR CONDENSING REFRIGERANTS

SINGLE RESPONSIBILITY:

Vogt, leading builder of refrigeration condensers, assumes responsibility for engineering the unit. Only one purchase order needed.

SHOP FITTED:

To cut down field assembly labor. Requires no cutting or fitting of pipe.

Designed for today's water conservation requirements, and to keep refrigeration costs low, the *new* Vogt Condenser Tower meets the need for a proven, readily cleanable condensing unit.

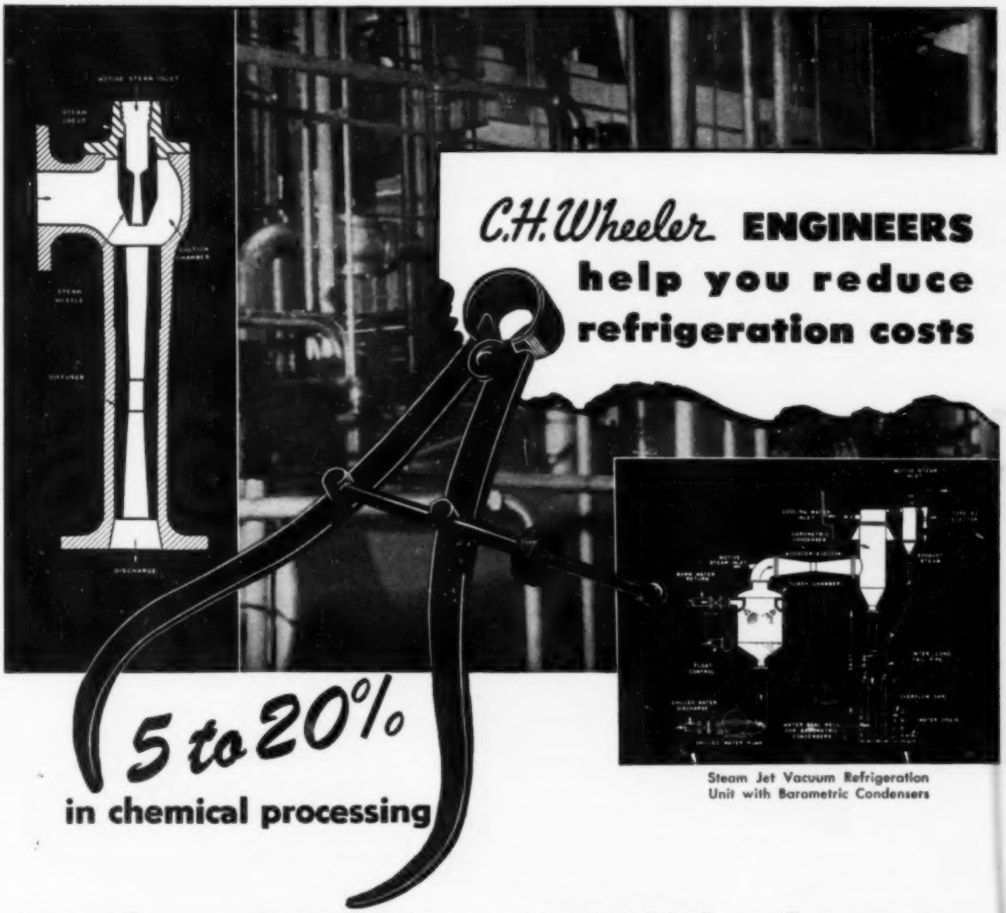
The Vogt Condenser Tower consists of a multipass straight tube condenser, a receiver, an oil trap, a cooling tower, and a water pump. Removable cast iron heads permit easy cleaning of the condenser tubes.

Water costs are extremely low since the cooling water is recirculated continuously and requires only a small amount of makeup to replace losses due to windage and evaporation.

Condenser Tower units are available in capacities ranging from 5 to 50 tons refrigeration. Additional information will be furnished upon request.

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.



Steam Jet Vacuum Refrigeration Unit with Barometric Condensers

They can help you save 5 to 20% over the cost of mechanical refrigeration, if you have live or exhaust steam available, and require moderate chilled water temperatures from 35° to 65°F. Purchase price is lower, because units are standardized in a wide range of sizes. Installation costs less. And — most important of all — long range maintenance cost is lower. There are no moving parts in the system except the chilled water pump.

Employing only water, cooled by flash evaporation, you eliminate hazards of noxious and poisonous refrigerants.

Most C. H. Wheeler installations are of a confidential nature. Our engineers will be glad to work with you in applying the correct vacuum equipment for your process.

Catalog 1462, yours for the asking, has many suggestions and charts of value to you who have a vacuum or refrigeration problem.

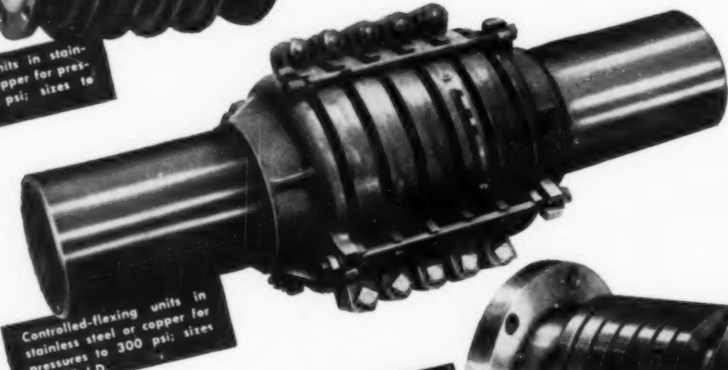
C.H. Wheeler OF PHILADELPHIA

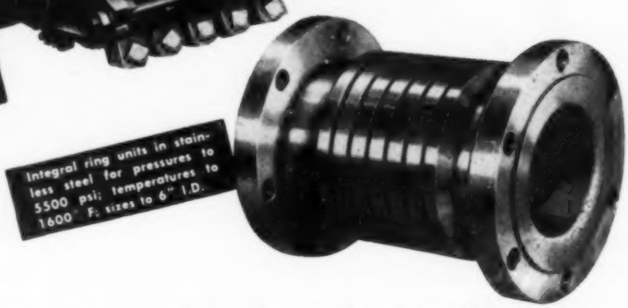
VACUUM REFRIGERATION—COOLING TOWERS—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—STEAM CONDENSERS—STEAM JET EJECTORS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

C. H. WHEELER MANUFACTURING CO., 1832 SEDGLEY AVE., PHILADELPHIA 32, PA.

Now, say FLEXON

when you specify expansion joints for piping





WITH the change of our corporate name from Chicago Metal Hose Corporation to FLEXONICS Corporation, CMH Expansion Joints are now known as FLEXON Expansion Joints. Just as the corporate name was changed to better describe the company's manufacturing activities, the name FLEXON should allow easier identification of these units.

Wherever motion is encountered in piping, the problem can be solved with FLEXON Expansion Joints. These dependable units are easily installed in new or existing lines and require only slightly more space than straight pipe. They cannot leak and require no maintenance.

Write for our new Expansion Joint "Design Guide". And remember, when you specify expansion joints, you now say, "FLEXON".

Flexonics Corporation

EXPANSION JOINT DIVISION
1317 S. THIRD AVENUE · MAYWOOD, ILLINOIS

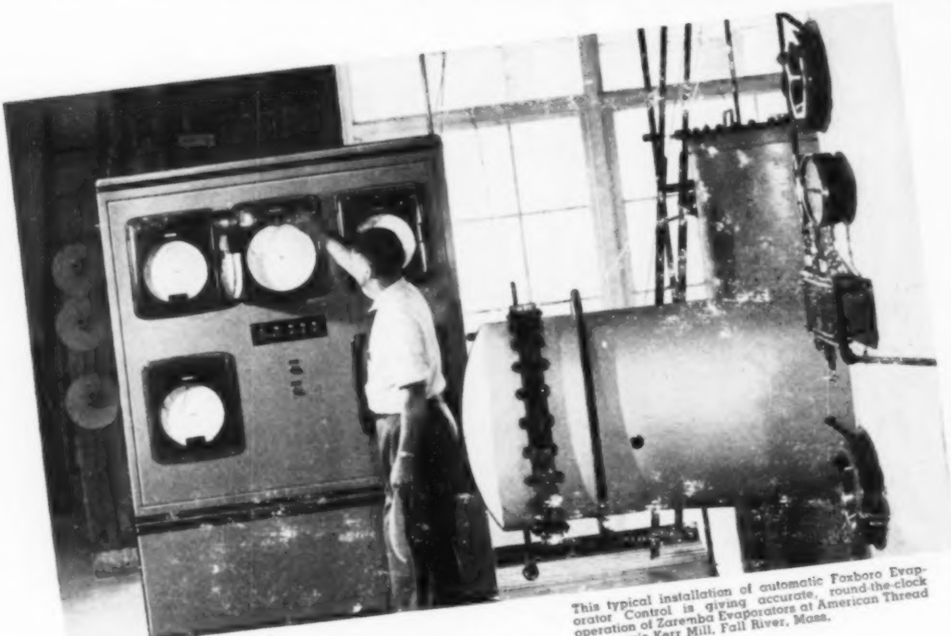
FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals · Expansion Joints for Piping Systems · Stainless Steel and Brass Bellows · Flexible Metal Conduit and Armor · Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Control Evaporator Concentration Automatically!



This typical installation of automatic Foxboro Evaporator Control is giving accurate, round-the-clock operation of Zaremba Evaporators at American Thread Company's Kerr Mill, Fall River, Mass.

. . . with an individually-engineered Foxboro Instrument System

In more than 40 plants throughout the country, evaporator concentration is being held at precise values, *automatically*, with Foxboro Control Systems. Some of these systems have been in daily use for as long as 4 years. The principles are easily and equally adaptable to virtually *any* polar solution.

Foxboro Automatic Evaporator Control is based on continuous measurements of "boiling point rise" . . . and on the exceptional sensitivity (1/100 of 1% of scale) of the Dynalog Electronic Controller combined with the high accuracy and stability of the Dynatherm Resistance Bulb. Pioneered and developed by Foxboro, this automatic control for evaporators offers you greater uniformity of end-product, increased evaporator capacity, elimination of spot sampling, and the release of needed manpower from purely routine tasks.

Write for engineering data sheet including full specifications and layout . . . and for a copy of the monograph "Quality Control in the Process Industries." **The Foxboro Company, 383 Neponset Avenue, Foxboro, Mass., U.S.A.**

Actual chart reproduced here shows concentration held continuously at 32½% NaOH with maximum deviation never exceeding ½ of 1%.

FOXBORO Reg. U. S. Pat. Off.

AUTOMATIC EVAPORATOR CONTROL

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

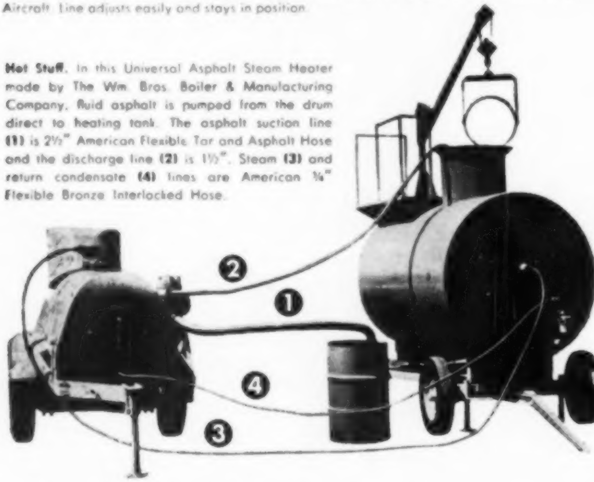
How in the world would **you** have solved these connector problems?

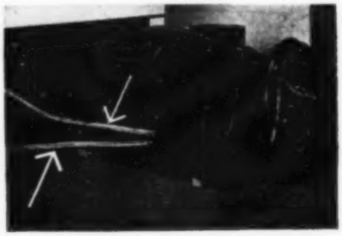
Coolent gets a new twist. A quick twist, and American Flexible Metal Tubing conveys coolant to just the right spot on this special lathe which machines jet engine parts at Pratt & Whitney Aircraft. Line adjusts easily and stays in position.

Would you have relied on costly, clumsy, rigid piping? Thrown up your hands? Or – like the resourceful designers of these three machines – would you have used flexible metal tubing? In each case American Flexible Metal Hose or Tubing filled the bill . . . and cut operating costs.

Your product, too, may need versatile, flexible American Metal Hose. If it must move, bend, or vibrate, let us show you the right connector...designed to absorb vibration, connect moving lines, or to be assembled in close quarters, while resisting heat, cold, pressure and corrosion in conveying liquids, gases or semi-solids. Write for Bulletins SS-50 and CC-300 which give technical details and many application histories. The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

Hot Stuff. In this Universal Asphalt Steam Heater made by The Wm. Bros. Boiler & Manufacturing Company, fluid asphalt is pumped from the drum direct to heating tank. The asphalt suction line **(1)** is 2½" American Flexible Tar and Asphalt Hose and the discharge line **(2)** is 1½". Steam **(3)** and return condensate **(4)** lines are American ⅝" Flexible Bronze Interlocked Hose.



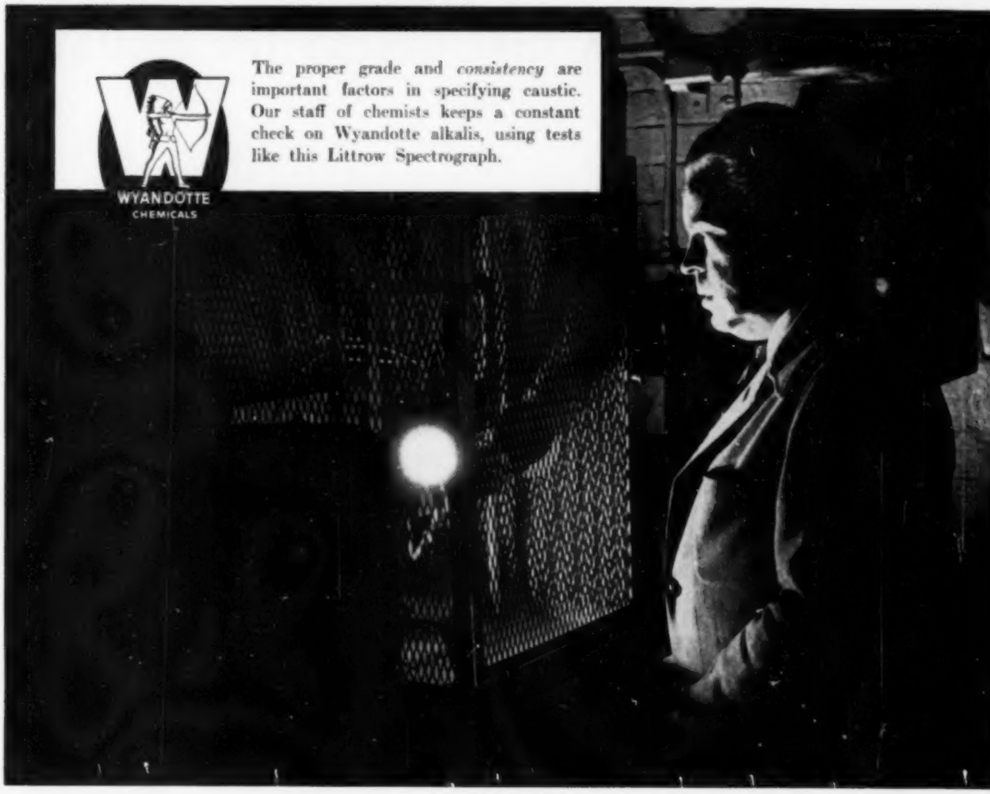


Pull-out is a push-over to repair. Tyler Fixture Corp. neatly solved the problem of permitting quick inspection and easy repair of the refrigerating unit in their freezers. Entire unit pulls out, yet refrigerant lines remain connected – thanks to American Seamless Flexible Bronze Tubing.

ANACONDA

wherever connectors must move

American **FLEXIBLE METAL HOSE AND TUBING**



These tests PROVE THE CONSISTENCY of every grade of Wyandotte Caustic!

Complete analyses of Wyandotte alkalis (read how you can make them) assure you of consistency and other advantages.

Among the many grades of Wyandotte Caustic Soda, you'll find the grades best suited to your needs . . . for soaps and detergents; food processing; paint, inks, and dyes; for insecticides, textiles, and lubricants.

Wyandotte Mercury Cell Caustic, for instance, meets the most *exacting* specifications. It's as pure as reagent grades! One manufacturer used to purify caustic in his plant — now uses Mercury Cell, eliminating the need for purification!

Complete alkali line

For caustic soda, soda ash, and bicarbonate of soda, for chlorine and calcium chloride, you'll find Wyandotte a reliable *and helpful* source.

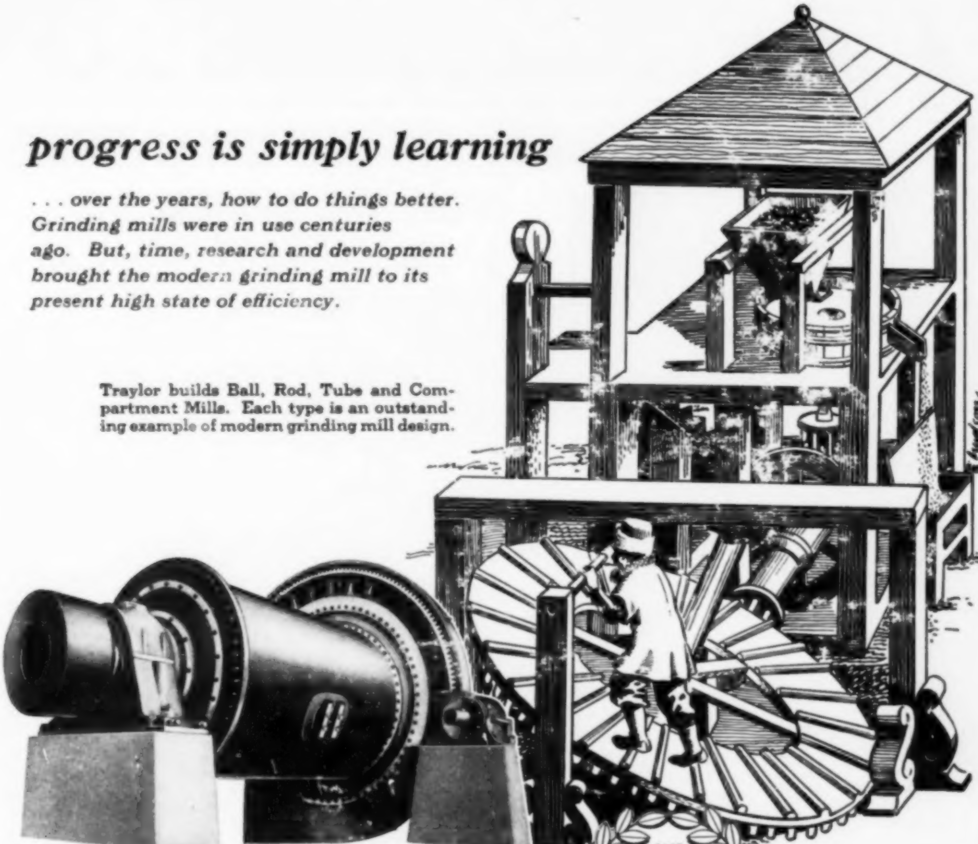
Our experienced staff of chemists is at your service for technical help. As a service to you, they have collected into a handy booklet the analysis procedure (mentioned above) for caustic, soda ash, and bicarb. A copy is yours for the asking. Why not write for it? — or for product data or technical help? *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in Principal Cities.*

Wyandotte
CHEMICALS

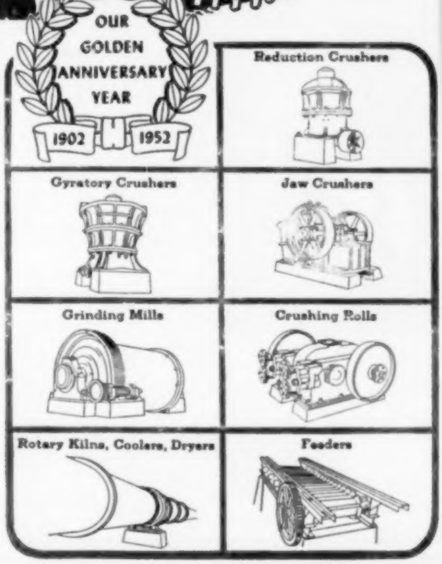
progress is simply learning

. . . over the years, how to do things better. Grinding mills were in use centuries ago. But, time, research and development brought the modern grinding mill to its present high state of efficiency.

Traylor builds Ball, Rod, Tube and Compartment Mills. Each type is an outstanding example of modern grinding mill design.



HALF A CENTURY has gone into the development and perfection of Traylor Grinding Mills . . . 50 years of experience covering countless grinding problems and processes. Processes and methods change radically over the years. As new problems arise only experience can provide a positive answer before large investments in equipment are made. Leading producers from all over the world depend on Traylor for the solution to their grinding problems. There's no substitute for experience. Traylor has experience . . . over half a century of it.



Traylor

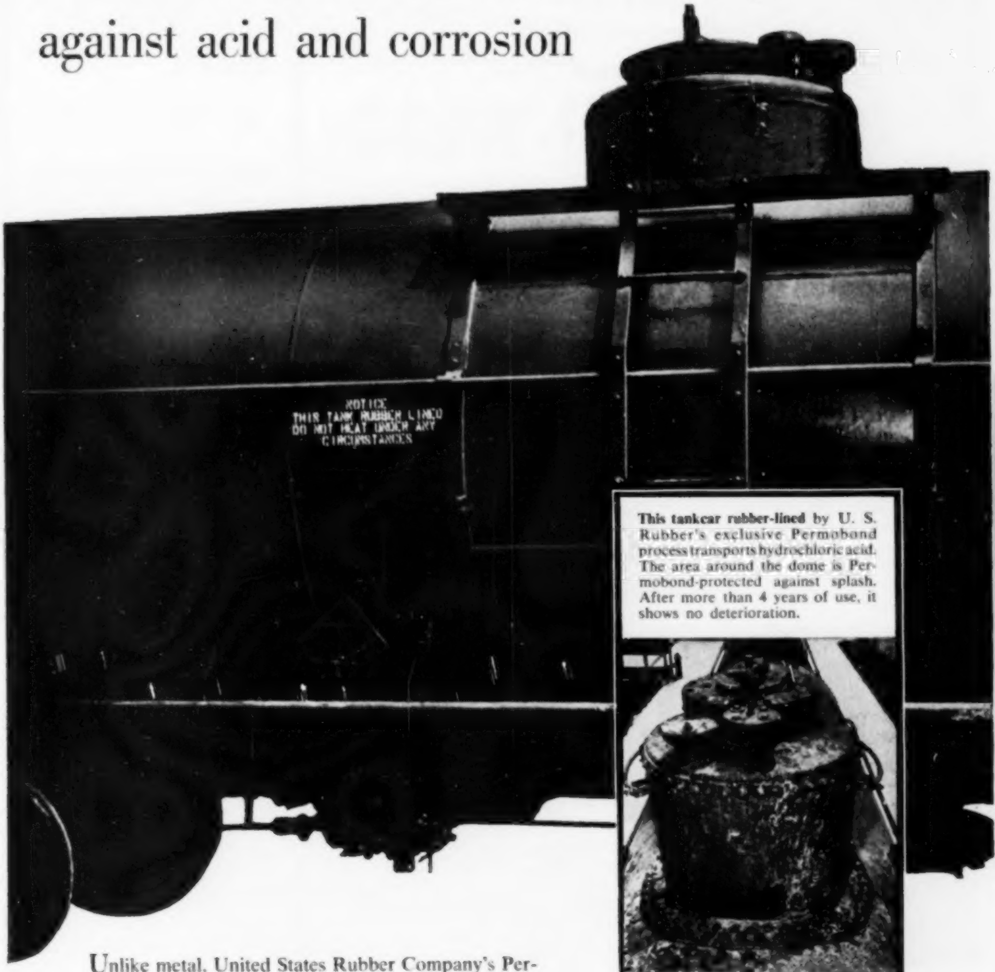
ENGINEERING & MANUFACTURING CO.

401 MILL ST., ALLENTOWN, PA.

Sales Offices: New York • Chicago • Los Angeles
Canadian Mfrs: Canadian Vickers, Ltd., Montreal, P. Q.

A TRAYLOR LEADS TO GREATER PROFITS

How U. S. Rubber's Permobond protects against acid and corrosion



This tankcar rubber-lined by U. S. Rubber's exclusive Permobond process transports hydrochloric acid. The area around the dome is Permobond-protected against splash. After more than 4 years of use, it shows no deterioration.

This dome, not protected with Permobond, has been in service only two years and already needs replacement. Original Permobond protection would have cost only a fraction of the total charge for this expensive replacement.

Unlike metal, United States Rubber Company's Permobond linings are not affected by acids and gases. Permobond linings are impermeable, and can be bonded or applied to almost any fabricated metal section, big or small, simple or complex. They save untold millions in replacement costs every year. United States Rubber Company engineers will gladly discuss your corrosion problems with you. Very often they can install and thoroughly vulcanize Permobond to existing equipment. Write to address below.

PRODUCT OF U.S.RUBBER SERVING THROUGH SCIENCE

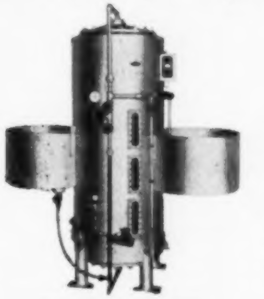
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

HIGH PURITY

WATER

For Process, Boiler Feed & Other Needs



THE LOW COST*

Penfield

MONO-BED WAY

Operating on the most efficient deionizing technique known (intimately mixed cation and anion resins in a single unit tank), raw water passes through a Penfield Mono-Bed Demineralizer only once, *yet comes out with resistances reported as high as 20,000,000 ohms.* No heat or steam power is ever required, and regeneration of the resins is accomplished by simple gravity and displacement methods.

***COSTS LESS, OPERATES FOR ONLY PENNIES**

Whether your requirements for dependable, high-purity water are 10 or 10,000 gph, there is a Penfield "Planned Purity" System waiting to make important savings for you in both original equipment and operating costs. Write today for new catalog showing all Penfield water-treating equipment.

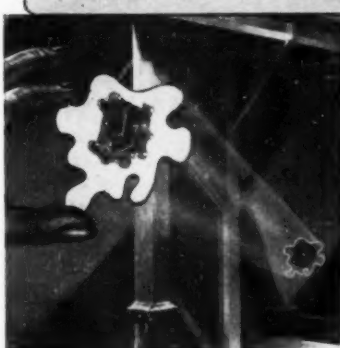
RUBBER-LINED, SARAN-LINED & NICKEL TANKS

Specially fabricated to suit your individual requirements by Penfield's Tank Fabricating and Lining Division. Write today for complete details.

PENFIELD MANUFACTURING CO., INC. 19 High School Ave. Meriden, Conn.

FILTERS SOFTENERS **Penfield "Planned Purity" PAYS!** DEGASIFIERS DEMINERALIZERS

FIT A SPECIFIC NEED



Assure Free-Flowing Bins, Hoppers and Chutes with

SYNTRON

"Pulsating Magnet"

ELECTRIC VIBRATORS

with variable control of power

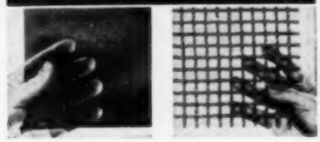
They are designed to meet a specific need—to eliminate the arching and plugging of bins, hoppers and chutes. Their 3600 pulsating vibrations per minute keep even the most stubborn materials flowing evenly thru bins, hoppers, chutes and screens—of any size—providing faster processing of materials without the hammering and rodding that wastes manpower and damages equipment.

WRITE FOR ILLUSTRATED FOLDER

SYNTRON CO.

610 Lexington Ave. Homer City, Pa.

You can count on CAMBRIDGE for all types of INDUSTRIAL WIRE CLOTH



FINE OR COARSE MESH

More than 600 different mesh sizes are available from 20 x 250 mesh up to 4" openings. Many popular items are kept in stock and can be shipped to you immediately.

ANY METAL OR ALLOY

Any metal or alloy that can be drawn into wire can be woven into wire cloth by our skilled craftsmen, including precious metals and unusual materials such as lead wire.

VARIED WEAVES

Cambridge industrial wire cloth is regularly produced in nine basic weaves. Single intermediate crimp through twilled dutch filter cloth, each of which has certain advantages for specific uses.

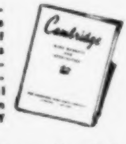
ACCURACY

You know the mesh count is right when you specify Cambridge. Every inch of cloth produced in our plant is carefully controlled by individual loom operators during weaving; each finished piece is again carefully inspected before shipping.

AND, FOR EXPERT ADVICE

on any problem of filtration, screening, sizing or other wire cloth uses, you can count on your Cambridge field engineer to provide the answer. Call on him freely. For information, write direct or look under "Wire Cloth" in your classified telephone directory.

FREE wire cloth reference manual. Gives complete range of sizes and weaves available from Cambridge. Also specifications, metallurgical data and fabrication facilities. WRITE TODAY



The Cambridge Wire Cloth Co.

Dept. G • Cambridge 3, Md.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

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MAGNABOND

magnetic coupling

A BASIC ADVANCE IN INSTRUMENTATION

. . . eliminates the stuffing box

. . . ideal for difficult fluids

SIMPLE
SAFE
PRECISE

Armored FLOWRATOR Meter with MAGNABOND operated close-coupled indicator-pneumatic transmitter.

The FLOWRATOR flow meter, combined with the patented separation-proof MAGNABOND magnetic coupling, provides the best means of metering any fluid. The MAGNABOND coupling picks up the FLOWRATOR metering float position without the need for stuffing boxes or torque tubes, thus providing an ideal solution for problems of metering corrosive or explosive liquids, slurries, or fluids under high pressure or temperature. The MAGNABOND coupling can operate indicators, recorders, totalizers, recording controllers, or pneumatic transmitters in various combinations—in close-coupled or remote instruments.

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FLOWRATOR

FISCHER & PORTER CO.

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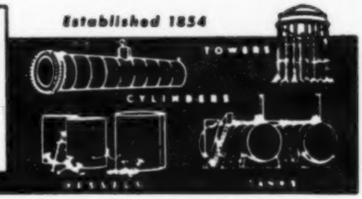
SALES ENGINEERING OFFICES THROUGHOUT THE WORLD

96 Years' Experience in TANK DESIGN

• For almost a century Cole elevated tanks have provided a dependable water supply for mills and communities. Cole quality is assured by careful, experienced designing and watchful supervision from blueprint to finished tank. Send us your inquiries for tanks from 5,000 to 2,000,000 gallons—stating capacity, height to bottom, and location. Write for latest Cole catalog—"Tank Talk."

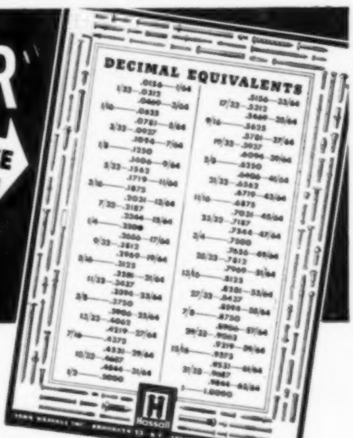
R. D. COLE
MANUFACTURING CO.
NEWNAN, GA.



WRITE FOR

FREE

Hassall decimal-equivalent wall chart

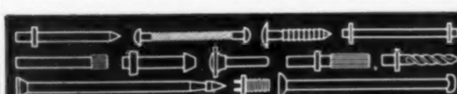


In such popular demand (we've given away 50,000)—we've made it better. The new chart is far easier to read! In three colors to automatically signal decimal-equivalents of fractions. The special products which frame the chart are a constant reminder of a good source for cold-headed parts.

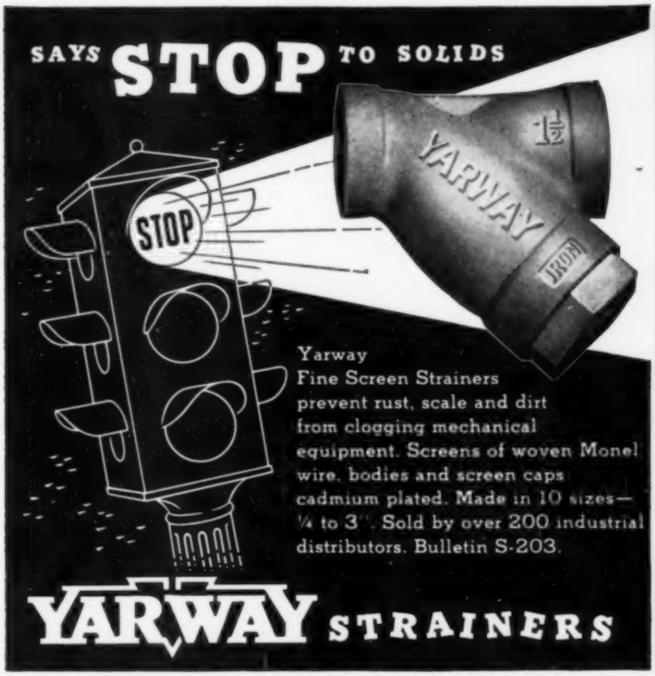
JOHN HASSALL, INC.

144 CLAY STREET • BROOKLYN 22, N. Y.

ESTABLISHED 1850

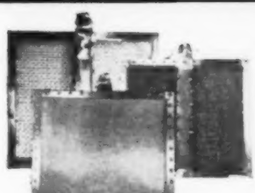


Hassall



YARNALL-WARING CO., 137 Mermaid Ave., Philadelphia 18, Pa.

Filter Leaves



Our Fabricating Department, working from customers' sketches or from our Design Service's drawings (based upon customers' requirements) produces filter elements of any size, construction and shape—single piece or sectional. Bolted closure for field disassembly, multiple filtrate outlets, weight saving and other special features can be accommodated. We invite your inquiries for filter leaves of unique or unusual design.

Write for catalog

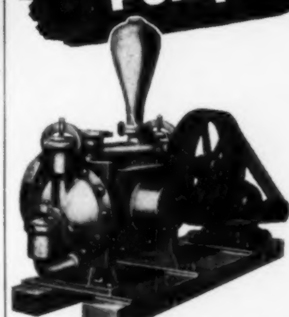
Multi-Metal WIRE CLOTH COMPANY, INC.
1356 Garrison Ave., Bronx 59, N. Y.

An Ever-Growing Number of Plants Pumping . . . . . .

- √ *Slurries • Sludges*
- √ *Corrosive • Abrasive*
- √ *Viscous • Thick*
- √ *Heavy • Valuable*
- √ *Delicate or Hazardous Materials*

are installing

SHRIVER Diaphragm Pumps



TO CUT *Operating and Maintenance Costs*

Because in this double reciprocating, positive action pump, heavy rubber or synthetic rubber diaphragms separate the liquid ends (and the materials handled therein) from the working mechanism. Thus, there can be no wear of the lubricant-immersed mechanism or contamination of the fluid. No packings, no leakage, no waste of materials, nuisance or hazards. Replacements and maintenance are minimized.

Liquid ends may be made of any metal or lining; pressures to 100 p.s.i.; capacities to 90 g.p.m. Hundreds of users' reports emphasize that Shriver Diaphragm Pumps "can really take it" and last longer.

Write for Bulletin No. 126

T. SHRIVER & CO., Inc.
802 Hamilton St. • Harrison, N. J.

To meet varying needs, Norton catalyst supports are available in spheres, rings, and pellets.

For Greater Yield or Lower Costs Investigate Norton Catalyst Supports

Products of 40 years of pioneering in the development of special refractories, Norton catalyst supports come in a variety of materials, structures, shapes, and sizes that cover practically every known requirement for these vital aids to modern chemical processing.

In particular, Norton spherical supports provide a bed of exceptionally uniform composition for the passage of gas, thereby reducing channelling and pressure drop to a minimum. Spheres are made in diameters of 1/8" to 3/4" of the following Norton refractory materials: ALUNDUM*, CRYSTOLON*, MAGNORITE*, FUSED STABILIZED ZIRCONIA, and MULLITE. Each material has its own special properties as a catalyst support, and each has the chemical stability and purity that eliminates contamination of both catalyst and end products.

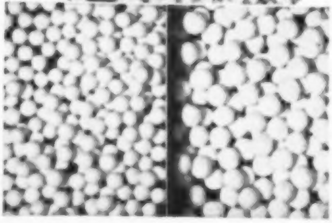
Also obtainable in these materials are Norton supports in ring or pellet form, in diameters of 1/8" to 2". Like the spheres, they have the high refractoriness and resistance to abrasion that insure long service life. Important advantages of all Norton catalyst supports are: controlled structure, highly suitable for coating or impregnation; porosity ranging up to 50%; and, in spheres, a choice of rough or smooth surfaces.

Make a Thorough Test

of Norton catalyst supports. Find out what they will do to improve your production through greater yield or lower costs. See your Norton representative or write direct for samples, describing your applications. Norton Company, 509 New Bond St., Worcester 6, Mass.

Canadian Rep. A. P. GREEN FIRE BRICK CO., Ltd. Toronto, Ont.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries



Spheres can be obtained with either smooth or rough surfaces.

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

IVAN is watching you

IVAN is a dyed-in-the-wool Communist. There are only 6 million party members like him in all Russia, yet these Communist brass-hats enforce the iron dictatorship of the Kremlin over *200 million* Russians.

He's sold to the hilt on Red ideas. Which means he's out to get you. He believes it's either you or him . . . that the world is too small for both.

Ivan is working hard to beat you down. He has a big head start.

Right now he's got you in a bad spot.

Ivan is afraid of only one thing.

He fears your ability to out-produce him in guns, tanks, planes.

Frankly, he doesn't think you value your free system enough to do it . . . to make willingly the sacrifices he has squeezed out of the Russians.

But he's wrong!

Because you and all of us have set out to build more and better weapons—to do it faster all the time.

We must use every bit of know-how and inventive skill we have to improve our machines and methods—to turn out more and more for every hour we work. Only in this way can we become militarily strong.

But we've got to supply essential civilian needs as well. We can't allow needless shortages to take prices skyrocketing and lower the value of our dollar.

Sure, that means sacrifices for everybody. But doing this double job well is the only sure way to stop Ivan in his tracks—and to save the freedoms which are ours and which he has never known.

FREE . . . this important booklet tells you how our American System Grew Great

How Americans developed better machines, power and skills to build a great nation . . . Why we have been able to produce constantly more per hour . . . How this has given us the world's highest living standard.

How we can meet today's challenge—Why we must expand our productive capacity . . . supply arms and essential civilian needs, too. Read how this dynamic process works in free booklet, "The Miracle of America," endorsed by representatives of management and labor. Send for your free copy today!

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THE STRONGER WE GROW

Need Cooling FANS?

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Aeromaster Industrial Cooling Fans

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- ***LONGER LIFE***
- ***GREATER ECONOMY***
- ***FAST SERVICE***

Koppers Aeromaster Fans are an adaptation of high-speed, top-efficiency aircraft propellers, resulting in longer life and improved anti-flutter performance. Aeromaster's high efficiency *cuts power costs up to 10%* . . . helps fan pay for itself.

Aeromaster Fans are available for every sizable industrial cooling requirement. Standard models range from 5 to 24 feet diameter, with 4, 6 or 8 blades, and in capacities up to 750,000 c.f.m. Easily assembled by unskilled labor. Engineering service furnished for special low-pressure propeller fan installations.

Every Aeromaster Fan is fully guaranteed by Koppers Company, Inc. Sales engineers available in all principal U. S. cities, as well as in Europe.

KOPPERS COMPANY, INC.

KOPPERS

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Aeromaster Fans
253 Scott St., Baltimore 3, Md.
Gentlemen: Please send me detailed information on Aeromaster Fans for

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(name and type of equipment to be cooled)

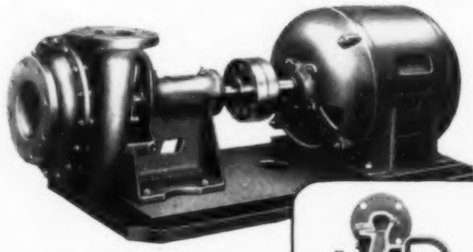
NAME ....

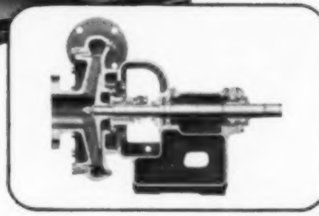
TITLE ....

COMPANY ....

CITY .... ZONE .... STATE ....

Goulds single stage... open impeller centrifugal





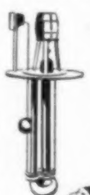
GOULDS Fig. 3169

Stuffing box provided with lantern-type seal ring and with tapped openings. In corrosive liquid pumping, seal may be connected to a fresh liquid supply or fitted with a special lubricator containing a nonsolvent lubricant. Mechanical seal may be substituted for stuffing box where desired.

Other GOULDS Pumps for the Chemical Industry

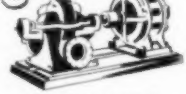
GOULDS Fig. 3705

Stainless steel pumps for handling acid and alkaline liquors. Capacities up to 600 G.P.M. Heads up to 160 ft.



GOULDS Fig. 3047

Nonclogging impellers of these vertical sump pumps will handle water containing large solids or fibrous materials.



GOULDS Fig. 3450

These double-suction, single-stage Goulds centrifugals will handle up to 15,000 G.P.M. Heads up to 500 ft. Send for Bulletin 721.2.

One pump that does many different jobs

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- Slurries
- Factory Wastes
- Transfer
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- Circulation
- And Many Others

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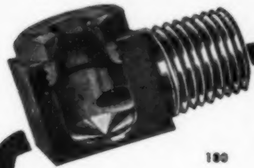

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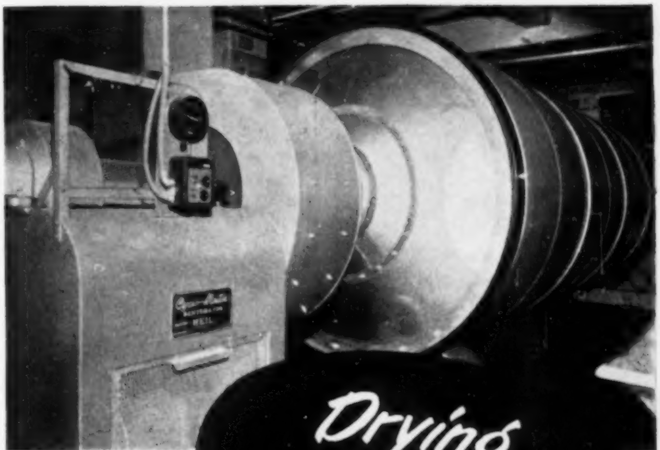

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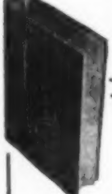

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Position CE-3-52

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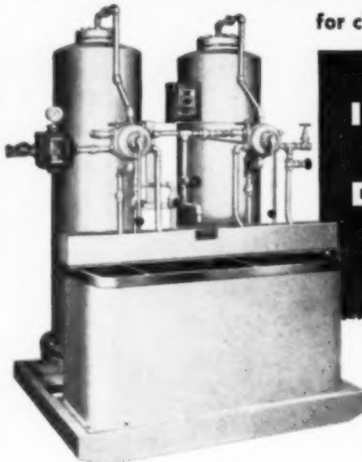

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Ask for Bulletin 200

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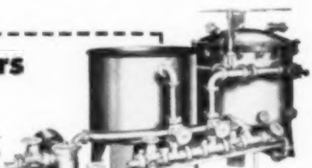
For Solution Clarification
Any Solution—Any Quantity



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Write for full information and recommendations

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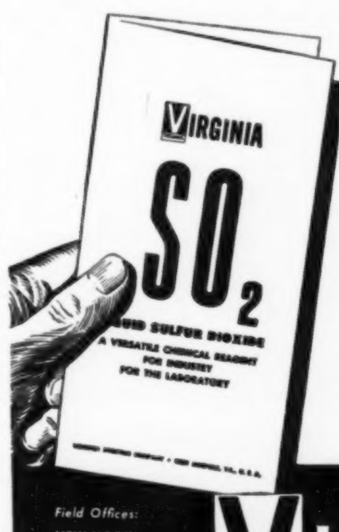

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ENGLAND. Corrosion Chemist required conversant with Metallic Corrosion and Treatments. Must be experienced. Applicants must submit full curriculum vitae and state salary required. Good prospects for permanent position. Box 18736 Urbach International Advertising, 63, Lancaster Grove, London N.W. 3.

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(Continued on page 440)

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P-2168, Chemical Engineering
330 W. 42nd St., New York 18, N. Y.

SELLING OPPORTUNITIES OFFERED

(Continued from page 439)

SALES ENGINEERS, with experience in the sale of mechanical equipment, wanted for positions involving general application and sale of heating, ventilating, and air handling apparatus for commercial and industrial buildings, industrial processes, and mechanical draft. Positions are available at various locations. Personal interviews will be granted only after receipt of written application giving full details of experience. Address: Sturtevant Division, Westinghouse Electric Corporation, Dept. AH, Hyde Park 36, Boston, Mass.

SALES OPPORTUNITY: Man wanted by industrial publisher to join sales staff of established, well-rated, highly regarded technical publication. Will cover an Eastern territory out of N. Y. office. Industrial background, training for or now working in connection with chemical process industries preferred. Openings with this organization are rare. Excellent opportunity for man 28-35. Salary, expenses, bonus. Reply in letter giving full details, education, experience, salary desired. SW-3414, Chemical Engineering.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 42 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. Bixby, Inc., 260 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL, $3,000-$25,000. This confidential service established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. B, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

CHEMICAL AND Mechanical Engineer. Diversified pharmaceutical, dye, rayon, and petroleum experience. Recently corporation engineer multi plant operation. Seek responsible position with small or medium size progressive company. PW-3562, Chemical Engineering.

CHEMICAL ENGINEER desires greater opportunity. Experienced in heat transfer, both sales and engineering, in industrial, oil refining, and marine. Oil refining and by-product coke plant operation experience. PW-3356, Chemical Engineering.

QUALIFIED CHEMICAL Engineer desires to relocate. Have extensive technical knowledge and enough leadership to handle plant personnel. Would like to do engineering but have experience mostly in production. I am making $5,000 a year and would like to do as well but located in the West or Southwest. If your plant needs someone with lots of experiences and ability to make processes run smoothly and profitably how about giving me a chance? PW-3341, Chemical Engineering.

SALES EXECUTIVE — 13 years experience — past 5 years organized own sales company, handling chemical process equipment. Silent partner—Internal Revenue took all the profits. Wants position Sales Management with concern serving chemical industry. Detailed qualifications on request. Now located Midwest. Will move. Reply to PW-3541, Chemical Engineering.

CHEMICAL ENGINEER: 34, research, design and production experience. Patents and publications. Seeks responsible position in production, and/or engineering in growing firm. PW-3615, Chemical Engineering.

FOR SALE

Yeast Plant,

including Turbo-Blowers of modern design in excellent condition, available for immediate delivery from factory now being shut down in England. FS-3504, Chemical Engineering.

MISCELLANEOUS

Is Your Mind New Enough

to make what is probably the most significant decision of your life? If you know it is. Then you are, in complete challenge, expressly invited to link your future with that of a group planning to move to central Chile summer 1952. These families, men and women, plan to bargain as a group for home sites and live together as neighbors to establish a Chilean corporation to develop some essential industries and begin rather significant possibilities. For application questionnaire, Write G. D. Krouse, 1536 Whitney Street, Augusta, Georgia.

Additional Wanted Advertising on page 448

"COME AND GET IT!"

IF IT ISN'T HERE WAITING FOR YOU

GELB

WILL GET IT FOR YOU QUICK

THE GELB GIRL—MARCH 1952

1—Sharples Stainless Steel Super D Canter #PN-14.
1—Koven Stainless Steel Mixing Tank, 1000 gals. with Nettco WT-37 Drive, 20 HP Explosion Proof Motor and Turbine Type Agitator.
1—Turbo #3B Drive with 10' Stainless Steel Shaft and Impeller.
1—Niagara #200 Filter, Stainless Steel Leaves.
1—J. H. Day Stainless Steel Jacketed Mixer, Sigma Blades, 50 gals.
1—Worthington Worthite Centrifugal Pump, 4" x 3" with 7½ HP Motor.

1—Sparkler Monel Jacketed Filter, Model #33-S-26.
1—Readco Stainless Steel Jacketed Double Arm Mixer, Sigma Blades, 225 gals. cap.
2—Buflovak Vacuum Shelf Dryers, 20 Shelves.
4—Turbo Steel Jacketed Mixers, 700 gals. each.
1—Fletcher Stainless Steel 20" Perforated Basket Centrifuge.
1—Stainless Steel Jacketed Vacuum Reactor, 500 gals. cap., with agitator.

2—J. P. Devine Steel Jacketed Vacuum Kettles, 2,000 Gals. Cap. Ea.
1—F. J. Stokes Steel Jack. Kettle, 500 Gals. Cap.
20—S.S. Jacketed Kettles, 380 Gals. Cap. Each.
1—Buflovak Cast Iron Kettle, 300 Gals. Cap.
2—Buflovak Cast Iron Jacketed Kettles, 1,500 Gals. Cap. Each.
1—Nickel Jacketed Vacuum Kettle, 400 Gals. Cap.
1—Nickel Jacketed Kettle, 500 Gals. Cap.
1—Nickel Jacketed Kettle, 10 Gals. Cap.
1—Evedur Vacuum Kettle, 2,000 Gals. Cap.
1—Alloy Fabricating Jack. Kettle, 1,460 Gals. Cap.
7—Copper Storage Tanks, 3,100 Gals. Cap. Each.
1—Blaw Knox Steel Jacketed Autoclave, 6' x 13'.
1—Blaw Knox Autoclave, 2 Gals. Cap., with Anchor Type Agitator.
2—Patterson Jack. Vacuum Autoclaves, 4' x 10'.
1—Baker Perkins Mixer, Size 6 with Vacuum Cover and Sigma Blades.
3—Baker Perkins Jacketed Double Arm Mixers, 100 Gals. Cap. Each with Sigma Blades.
2—J. H. Day Mogul Mixers, 2½ & 5 Gals. Cap.
1—J. H. Day Jacketed Mixer, 150 Gals. Cap. with Sigma Blades.
9—J. H. Day #3 Brighton Mixers (Pony Type), 175 Gals. Cap. Each.
18—Simpson #0 Intensive Mixers.
1—Fitzpatrick Model D Comminuting Machine, Stainless Steel & Bronze Construction.
1—Mikro #1-SH Pulverizer.
1—Mikro #2-IH Pulverizer, Stainless Steel & Bronze Construction.
2—Mikro Stainless Steel Atomizers, #5 & #6.

1—Nash Vacuum Pump Model H-7.
1—Fuller Model C-200 Compressor.
1—Fletcher Underslung Centrifuge, 20" Steel Imperforated Basket.
5—Sharples #16 Stainless Steel Centrifuges, Size 6, Type 1-JY.
1—Tolhurst Stainless Steel Suspended Type Centrifuge, 40" Imperforated Basket.
1—Buflovak Double Drum Dryer, 24" x 36".
1—Buflovak Double Drum Dryer, 32" x 90".
1—Louisville Rotary Steam Tube Dryer, 6' x 50'.
1—Ruggles Cole Rotary Kiln, 7½' x 60'.
2—Downington Stainless Steel Heat Exchangers, 500 sq. ft. each.
1—Shriver 24" x 24" Cast Iron Filter Press, 30 Chambers, Open Delivery, Washing Type.
2—Shriver 36" x 36" Cast Iron Plate & Frame Filter Presses, 25 Chambers, Closed Delivery, Side Feed.
1—Shriver 36" x 36" Cast Iron Plate & Frame Filter Press, 49 Chambers, Closed Delivery, Steam Jacketed.
1—Shriver 42" x 42" Filter Press, 38 Wooden Plates & Frames, 3 Eye, Closed Delivery.
3—Shriver 56" Filter Press Skeletons with Hydraulic Closing Device.
1—Sperry 24" x 24" Aluminum Plate & Frame Filter Press, 22 Chambers, Open Delivery.
1—Sperry 30" x 30" Cast Iron Filter Press, 34 Chambers, Recessed Type.
1—Sperry 42" x 42" Cast Iron Plate & Frame Filter Press, 18 Chambers, Closed Delivery.
3—Sweetland Filters #2, 5 & 7.
2—Groen S.S. Jacketed Kettles, 20 & 50 Gals. Cap.
1—Stainless Steel High Pressure Hydrogenator, 360 Gals. Cap., Working Pressure 250 PSI.

Established 1886

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

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QUICK DELIVERY ON GUARANTEED EQUIPMENT

Large Stock at our Brooklyn Warehouse & Shop

DRYERS & KILNS

2—Ruggles Coles 7½' x 60' & 6' x 45' Rotary Dryers
1—Allis-Chalmers 10' x 90' Rotary Kiln
1—B&S 8½' x 50' Rotary Kiln
6—Rotary Dryers, Direct & Indirect. Also Jacketed & Steam Tube.
New Rotary Dryers, Kilns & Coolers built to order.
2—Proctor 6 fan automatic Conveyor Dryers.
2—Albright-Neill 4'x9' Atmos. Drum Dryers.
1—Buffalo Vac Drum Dryer 24x20". Also Rotary Vac. Dryers & Vac. Shelf Dryers.
6—Steam, Gas & Electric Dryers, Tray & Truck.

CENTRIFUGALS & CENTRIFUGES

5—Tolhurst 40" Suspended Type Centrifugals. Bottom Discharge. Motor Driven.
6—Centrifugals 20", 30", 40" & 48", Steel, Copper, Stainless & Rubber Lined.
12—Sharples Centrifuges #5A Stainless. Also #6.
3—De Laval Multiple Clarifiers #200, 300 & 301.

FILTERS

1—Valley 41 Stainless Covered Leaf Filter, type 40.
3—36" x 36" Corner Feed Iron Filter Presses.
10—Sperry & Shriver 7", 12", 18", 24", 30", 36", 42". Iron & Wood Filter Presses.
1—12" Bronze Filter Press.
Extra 36" & 40" iron plates & frames.
Sweetland & Oliver Rotary Vac. Filters.

KETTLES & TANKS

1—Steel ASME 275 PSI Pressure Tank. 1200 gals.
Divine 1000 ga. closed jack agit. steel kettle.
8—Jacketed Kettles 50 to 1000 gals.
1—250 gal. Lead Lined Kettle.
1—1000 gal. Stainless Agitated Tank.
New Stainless Steel Tanks 50 to 500 gals.
30—Stainless, Alum., Copper, Glass & Lead Lined Kettles & Tanks.
6—Copper Varnish Kettles 150, 200 & 300 gals.

PULVERIZERS & MILLS

1—#32 Raymond Pulverizer with 20 H.P. AC motor. Vac. Separator & Cyclone Collector.
1—Raymond #00 Pulverizer 30 HP. Complete.
4—#0000 Raymond Mills.
1—Mikro Pulverizer 2DH, 10 HP, & other sizes.
8—Hammer Mills & Pulverizers 3 to 50 H.P.
1—Schutz-O'Neill 20" Pulverizer. Also #1.
1—Sturtevant 30" Rock Emery Mill.
1—Robinson 22" Attrition Mill.
1—Lehman 4 Roll W. C. 12" x 36" Steel Mill.
3—Lehman & Kent 3 Roll Steel Mills. 8"x22", 9"x32", 12"x36", 6"x40".
1—9" x 36" Double Steel Roller Mill.
1—9" x 24" 3 pr. high steel Roller Mills.
3—Houchin 10" x 30", 4 Roll Granite Stone Mills.
2—Abbe Pebble Mills, 6'x8' & 36"x42".
8—Abbe Jar Mills Lab to 25 gal. sizes.
Ball & Jewell & Leominster Rotary Cutters.
1—U. S. Colloid Mill 1½ HP Motor.

MIXERS—ALL TYPES

Baker-Perkins heavy duty double arm Mixers, 200, 9 and 4½ gals.
Horiz. Mixers single & double arm to 200 gal.
Day 40 gal. Pony Mixer & other sizes.
1—Century 2 HP, 4 speed Vert. Mixer.
6—Lead & Paste Mixers 50 to 150 gals.
Patterson 3½' dia. Stainless Conical Blender.
1—Master Drum Type Blender 1000#.
10—Dry Spiral Mixers 50 to 2000 lbs.
12—Portable Elec. Liquid Mixers ¼ to 3 HP.

SCREENS & SIFTERS

2—Tyler #38 Jr. Hummer Screens, 20" x 30".
2—Gyratory suspended Sifters 20" & 24".

MISC. & SPECIALS

4—200 Ton Brunswick 16" upstroke Record Presses.
4—French Oil Linseed & Cottonseed Hydr. Presses.
1—Goulds 75 HP, 2 stage motor driven Centrifugal Pump, 250# WP.
4—French Oil Motor Driven Expellers.
New 6" x 12" Lab Mixing Mills & Calenders.
4—Farrel 15" x 36", 16" x 48" & up to 22" x 60' 2 Roll Mixing Mills.
3—Rubber & Plastic Extruders 1' to 6".
1—Stokes 2E Paste Filler up to 5 gal.
1—Marco #200 Stainless Steel Homogenizer.
1—Stokes & Smith & Day Powder Fillers.
6—Filling Machines, Liquid, Paste & Powder.
Rotary & Single Punch Tablet Machines, ½" to 3".
2—Howe Mogul Barrel Bag Packers.
2—Revolving Pans 30" & 36".
4—Stokes Vert. High Vac. Pumps.
2—Worthington 12" x 12" x 12" Vac. Pumps.
6—Devine & Buffalo Vac. Pumps.
Soap Machinery for Toilet Laundry Chip Liquid.
Hydr. Presses, Pumps & Accumulators for Rubber & Plastics. Injection Molding Machines.
Boilers, Gas, Oil & Coal Fired.

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PARTIAL LISTING. WRITE FOR BULLETINS. PHONE: WORTH 2-5745

STEIN EQUIPMENT COMPANY

90 West Street, New York 6, N. Y. Cable: Machequip

AIR SEPARATORS: 1—Raymond, one Sturtevant and one Gayco 16 ft. with 50 H.P., 220/440 volt motors. Used only 6 months on material only slightly abrasive.
CLASSIFIERS: 4—Akins 54" and one 30", Simplex, single screw, Weir type, with 440 volt, AC motors. Also, 1—Wemco. 1—Dorr class DSFXB, 22' dia. bowl, 8' x 39' rake with 440 volt motors, used only six months.
DRYERS or KILNS: 2—Allis Chalmers 10 ft. x 90 ft., heavy duty, plate thickness 9/16", complete and with or without coal fired Furnace, Western Precipitation Dust Collector, Clarage #41 Exhauster, Motors, control equipment, etc. 1—4' x 60 ft., complete, oil fired.
PULVERIZERS: Hardinge Mill size 5 ft. x 22", steel lined, complete with disc feeder and 30 H.P. motor. 1—10 ft. x 36", Hardinge Conical Ball Mill with 300 H.P. motor and all auxiliary equipment for dry grinding. 1—6' x 30" silica lined. 1—Sturtevant 1½ Ring Roll Mill. 1—3' x 4' Elmco Ball Mill complete with liners, ball charge, V-belt drive and 20 H.P. motor and control. NEW, UNUSED.
THICKENER: Dorr with 20' x 12' deep tank, complete.
COMPRESSORS: Worthington 2 stage, 29/18½ x 21, type DC2, 600 H.P., synchronous motor, 3 phase, 60 cycle, 440 volt, 180 RPM, cap. 3000 CFM, 100 lbs. pressure, complete with auxiliary equipment. In operation now, available immediately. 1—Worthington 15—9½ x 12, cap. 700 CFM @ 100 lbs., direct connected to 400 volt, 125 H.P. synchronous motor, with all auxiliary equipment.
DIESEL MOTOR: 122 H.P. Caterpillar D13000 complete with clutch, V-belt pulley and spare parts.
BOOT BUCKET ELEVATORS: 2—63 ft. cc manganese steel chain, buckets 16" wide. 1—70 ft. cc buckets 8 x 5 on #78 Reliance chain. NEW, UNUSED.
MAGNETIC PULLEY: 24" with 1½ KW MG set with or without 24"x160' conveyor, 7½ H.P. motor and drive.

A. J. O'NEILL

Lansdowne, Pa.

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DOWTHERM VAPORIZER

1,000,000 B.T.U.

FOR SALE

#33-3A McKee Gas Fired, receiving tank, condensers, coolers, Nikroloy Pump, interconnecting piping, valves and fittings.

THE O'BRIEN MACHINERY CO.
1555 No. Delaware Ave. Phila. 25, Pa.

Autoclaves, Nickel, 32"x5'6", 600 PSI, Direct Fired. **NEW Porcelain Mill Jars.**

Mills, Hardinge—7'x48", 8'x22" w/motor drives.

Mills, Raymond #1, w/separator/cyclone. Sturt. #1 Ring Roll, Wms. LG-1, Prater 100 Blue Streak.

Rotary Kilns, 24"x18', 4½'x40', 5'x50', 6'x50'.

Filters—Laughlin, Bird 4'x2', Sweetland #5, #12, s/s and Bronze.

Vacuum Pumps—Nash Hytor H5—Devine 10"x10", IR 4"x4"x2⅜".

Crushers Jaw—6x9, 8x14, 14x26, 24x36.

Crushers Roll—12x12, 10x16, 20x16, 48x18.

12,000 gal Steel Tank—8'x32'.

New Pumps—Compressors—Exhausters.

LAWLER COMPANY

Durham Avenue Metuchen, N. J.
Metuchen 6-0245

FOR SALE

3—32"x90" Buflovak Double Drum Dryers.
100 to 250 gal. S.S. Mix Tanks, water jkt.
3000 gal. S.S. Truck Tanks, Trailerized.
160 gal. S.S. Clad Jkt. Kettles, 30"x52".
150 gal. S.S. Jkt. Kettle, 42"x34", agit.
Copper Still 44"x32", coil condenser.
300 gal. Pfaudler Horiz. Glass Line Tank, 25#.
4—50 gal. Steel Kettles, 75# jkt., A.S.M.E.
Premier Colloid Mill 6", 7½ H.P. motor.
Gruendler Jr. Pulverizer, 10 H.P.
75 to 1500 gal. Homogenizers or Viscolizers.
26" Centrifugal Extractors, copper baskets.
60" Centrifugal Extractors, s.s. baskets & curbs.
Model 148C Stokes High Vacuum Pump, 1½ H.P.
2" S.S. Centrifugal Pump, 5 H.P.
15 H.P. Lookout Vert. Tubular Boiler.
7 H.P. McKee Gas Fired Boiler.

Send us your inquiries

LESTER KEHOE MACHINERY CORP.
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"RISE AND PROFIT!"

We are ready to buy
YOUR IDLE MACHINERY

Dryers, all types	Reaction Kettles
Filter Presses	Jacketed Kettles
Mixers	Rotary Filters
Pulverizers	Storage Tankage
Evaporators, Stills	Hydraulic Presses
Columns	Flakers
Roller Mills	S/S Tanks & Kettles
Screens & Sifters	
Packaging Units	

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Single items to complete plants

IMMEDIATE SHIPMENT

FILTERS & FILTER PRESSES

1—Shriver, iron steam heated, 30" x 30", 30 chambers.
4—Shriver & Johnson, 30 x 30 iron plate and frame, 35—40 chambers each.
1—8' x 12 Oliver Lead-Wood Vacuum Filter Acid-Resisting.
3—Oliver Vacuum Filters, incl. 8 x 12' 11'6 x 14' 11'6 x 18'.
2—ALUMINUM Sperry FILTER PRESSES: 1—30' x 30" 45 chambers, 1—24" x 24" Plate and Frame, 24 chambers.
1—#12 Sweetland Filter 36 leaves on 4" centers.
1—Kilby 39 x 39 CI Filter Press open delivery.
1—#5 Sweetland, Stainless Steel Lined with 30 stainless steel leaves on 2" centers.
1—Sperry 24" x 24" P. & F. Filter Press with 25 chambers, 2" frames.
4—Shriver 36" x 36" iron plate and frame filters, centerfeed

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SAVE REAL MONEY AND TIME — BUY

"CONSOLIDATED"

DRYERS

1—3' x 28' MONEL shell hot air Dryer, saw tooth flights, steam coils, etc.

1—5'6" x 24' Direct Heat Rotary Dryer or Rotary Kiln, welded shell.

1—7' x 70' Louisville Type L, Indirect-Direct Heat Rotary Dryer.

4—Buflovak 5' x 12' double drum Dryers.

1—Devine #7 Vacuum Shelf Dryer, 13 shelves 40 x 43.

2—Buflovak Double Drum Dryers 32' x 90" complete with stainless steel accessories.

1—Devine Rotary Vacuum Dryer, 2' x 8', also 5' x 25'.

2—Buflovak Vacuum Drum Dryers, 5' x 10' with all accessories.

1—6 x 50 Louisville welded shell Rotary Steam Tube Dryer with two rows, 54 tubes. Also two 6' x 27' Davenport same type.

3—J. P. Devine Double Door Vacuum Shelf Dryers: each equipped with 20 heated welded shelves, 58" x 78" pumps and condensers.

1—F. J. Stokes 14 shelf, 44" x 44" Vacuum Shelf Dryer with vacuum pump and condenser, etc.

2—5' x 40' Ruggles-Coles Direct Heat Rotary Dryers.

1—American 42" x 120" atmospheric double drum Dryer.

JACKETED KETTLES

3—1000 gal. Pfaudler, plain steel, jack.

1—1000 gal. Stainless Steel, jack. agit.

45—Aluminum & Stainless Steel 20 gal. to 150 gal.

1—500 gal. open agitated.

2—Lee 200 gal. S-S Kettles, 125#.

4—Burkhardt Copper, 275 gal.

1—Copper 800 gal. turbine agitated copper coils.

1—100 gal. and one 150 gal. Dopp small C.I. dbl. motion agitated.

1—10' dia. x 4' Bartlett and Snow 1800 gallon, with agitator, 9/16" plate, 80 lbs.

1—300 gallon s/s jacketed kettles, 100 lb. pressure, with cover and B. O.

EVAPORATORS

1—Swenson triple effect Evaporator, horizontal copper tubes, total 1320 sq. ft. H.S. Now installed and complete with supporting steel condenser, pumps, piping, etc.

Also used as Finishing Pan—

1—Swenson single effect Evaporator, copper tubes, 440 s. ft. H.S. with supporting steel condenser, pumps, piping, etc.

MIXERS

4—Baker Perkins, jack. Mixers, 3,000 gal., size 30, type X.

1—100 gal. jack. B.P. Mixer, heated blades.

1—Patterson 110 gal. S.S. Vacuum Kneadmaster.

1—Day #10 Cincinnatus, jack. 343 gal.

1—Baker Perkins, size 8, 5 gallon working capacity, jacketed Laboratory Vacuum Mixer with Cleveland Reduction Drive and 5 HP, AC motor.

1—AMF 340 qt. Glen Mixer, 2 S-S Bowls and beaters, md — new 1949 — practically new.

3—AMF 160 and 120 qt. Glen Mixers, 20 S-S 80 and 160 qt. bowls and beaters, md. new 1949 — practically new.

CENTRIFUGALS

2—42" All STAINLESS STEEL, Centrifugals. Amer. T&M Co. with S/S basket, curb, casing, shaft unloader and 40 H.P. variable speed Slip Ring 3/60/440 V 1200 RPM motor with full controls. Suspended bottom discharge type. Now at Newark.

1—Tolhurst susp. Centrifugal with perf. 40" MONEL basket. Bottom discharge, 2 speed, 20 h.p. 5 h.p., 3/60/440V Motor. All contact parts Monel. Still erected, can be seen in operation.

"A DOLLAR SAVED IS A DOLLAR EARNED"

MISCELLANEOUS

5—Lightning portable Agitators, 1—1½ H.P., s/s shafts.

4—Mikropulverizers, Model 4TH, 24"—SI—TH.

350—Stainless Steel Dryer Trays, 34" x 34" x 1½" deep.

1—Copper Rectifying Column, 6 sections, 30" dia x 33' high, bubble cap type.

15—Dry Powder Mixers and Blenders, rotary and horizontal ribbon type, 100 to 5000 lb.

1—Capem, S.I.F. Capper, cap feeder, m.d.

4—Swenson-Walker, jacketed, Crystallizers.

1—6" x 15" Sturtevant Jaw Crusher to ½".

1—24" x 15" Sturtevant Crushing Rolls, balanced type.

1—5-Roll Raymond High Side Pulverizer.

1—Stokes DD2 Rotary Tablet Machine, Reeves drive and motors.

2—Paul O. Abbe 30 gallon Pebble Mills with gear reduction; V-belts and 1½ HP motors.

10—Trane 24" x 48" double coil heater units, copper, with eight exhausters, each with 5 HP motors.

Many hard-to-get items listed on both these pages

5—9800 Gal. Horizontal Stainless Steel Storage Tanks #304 S/S lined, now equipped for mixing and also jacketed for steam or for cooling.

BUY WITH CONFIDENCE

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The Oldest and Largest Dealer in Rebuilt Chemical Machinery

SOLIDATED PRODUCTS COMPANY INC.

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A "BRILL BUY" *is the Best Buy*

A QUARTER CENTURY OF DISTINGUISHED SERVICE

DRYERS—KILNS

1—9'6" x 8'6" x 200'—¾" shell
2—7' x 8'6" x 135'—¾" shell
1—8' x 135'—⅝" shell
1—8' x 115'—⅝" shell
1—8'6" x 108'—½" shell
1—10' x 90'—½" shell
1—9'6" x 83'—¾" shell
1—6' x 60'—¾" shell
1—Link Belt 11'6" x 35' Roto-Louvre
1—Link Belt 2'7" x 8' monel Roto-Louvre
6—Rotary Dryers 7' x 70', 7' x 60', 5' x 67', 4'6" x 40', 4'6" x 25', 4' x 20'
4—Louisville Rotary Steam Tube Dryers 6' x 50', 6' x 30', 4'6" x 25'
2—Buflovak 20 and 15 shelf Vac. Dryers
5—Stokes & Buflovak Rotary Vacuum Dryers 30" x 8', 5' x 20', 3' x 15', 6'6" x 38'
1—Blaw-Knox Stainless Steel Rotary Vac. Dryers 42" x 8'
2—Buflovak 32" x 100" Atmos. Double Drum
1—Single Drum 60" x 80" Flaker
1—14 Truck steam heated Dryer 1680 sq. ft.

SCREENS

5—Sprout Waldron Stainless Steel Single Deck, 40"x84"
1—Robinson Rotex Single Deck 40"x84", 40" x104"
1—Tyler Hummer 4'x7' Single Deck
5—Tyler Hummer 3'x5' Triple Deck
1—Abbe #2 Bluterguss Sifter

FILTERS

4—Vallez #69 Pressure 1280 sq. ft.
4—Vallez #59 Pressure 945 sq. ft.
2—Sweetland #12 with 36 and 72 leaves.
2—Sweetland #7 with 27 steel leaves.
8—Oliver Rotary Vacuum 11'6" x14', 8'x12', 8'x10', 8'x8', 3'x4', 3'x1'.
3—Eimco Rotary Vac. 8'x8', 4'x5', 4'x4'.
1—Oliver Rotary Vac. Precoat 3'x4'.
1—Feinc Rotary Vacuum 8'x12'.
2—42" P&F, 55 chambers, 2".
4—Shriver 36" P&F, 30 chambers.
1—Sperry 36" Recessed, 48 chambers
5—Shriver 30" P&F, 30 chambers
8—Sperry 24" P&F, 16 chambers.
1—Shriver 24" Recessed, 30 chambers.
3—Shriver 18" Recessed, 30 chambers.
2—Sperry Aluminum 30" and 24" P&F, 22 and 26 chambers.
1—Shriver Aluminum 12" P&F, 8 chambers.

FEATURED ITEMS

1—9'6"x200', ¾" shell, Rotary Kiln
2—7'x8'6"x135', ¾" shell, Rotary Kilns
1—8'x135', ⅝" shell, Rotary Kiln
2—6' dia. x 30' high S. S. Bubble Cap Columns
2—Oliver monel 8'x10' Rotary Vac. Filters
1—Rogers Spray Dryer 16' dia., with all accessories
1—Steel 2000 gal. jacketed, agitated, 200 psi Reacter
1—Bethlehem 1400 gal. steel, jacketed Still
1—1000 gal. jacketed, agitated Steel Kettle
3—Dopp 250, 150 gal. jacketed, agitated kettles
5—Steel Storage Pressure and Acid Vessels 3500 to 20,000 gals.
1—Buflovak VRC, stainless steel Single Effect Evaporator, 94 sq. ft.
1—Buflovak VRC, Triple Effect, 900 sq. ft.
1—Buflovak 6' dia. Vacuum Crystallizer
2—NEW Absorption Towers, 13,500 gal. cap.
10—Steel Tanks 9000 to 100,000 gals.
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1—AT&M 42" Suspended S.S.
6—AT&M 40" Bronze Baskets
1—Fletcher 48" Suspended, bottom discharge, S.S. perforated basket.
1—Tolhurst 32" Suspended Monel.
1—Tolhurst 32" Suspended S.S.
1—AT&M 20" Rubber Covered
2—Bird 38"x50" solid bowl, stainless
1—Sharples P14 S.S. Super-D-Canter
4—Sharples #16 S.S. and steel

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2—Raymond 4 Roll High Side Mills
1—Raymond 3 Roll High Side Mill
1—Bauer 38" Attrition Mill 2—50 HP motor.
17—Patterson, Abbe Pebble & Ball Mills 60 to 1000 gals.
2—Premier Colloid Mills 8" dia., S.S.
1—Eppenbach QV7 Colloid Mill
2—Jeffrey 36"x24", 20"x12" Hammer Mills
2—Raymond 8', 4' Air Separators
1—2 Roll Rubber Mill 6"x12"
1—5'x22' Tube Mill
2—Fitz Comminuting Mills 7½ HP

MIXERS—ALL TYPES

1—Baker Perkins 300 gal. Unidor S.S.
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1—Baker Perkins 2 gal. Stainless
1—Day 100 gal. Cincinnatus jktd. double arm
1—Day 30 gal. Imperial jktd. double arm
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4—Day, Ross, 8 and 50 gal. Pony Mixers
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MISCELLANEOUS

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7—Stokes Vacuum Pumps 15 to 100 CFM.
1—Milton Roy Proportioneer Pump, S.S. and Hastelloy, 10 GPM
1—Oliver Horizontal Dry Vacuum Pump 400 CFM
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1—Colton Single Punch Tablet Machine #5½
4—Stokes DD2, D4 Rotary Tablet Machines
1—#1 Anderson Expeller
1—Nash A1673 Hytor Vacuum Pump, 40 CFM
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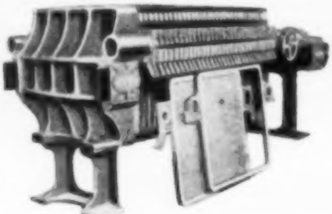

4 Bird-Young Rotary Vacuum Filters; 24" x 48" and 52" x 48"
Oliver Rotary Vacuum Filter; Dorrco type; 6' x 3' nickel contacts
2 Sweetland No. 12 Stainless contacts; pressure leaf type

MAKE	SIZE	TYPE	CONTACTS	CHAMBERS	FEED	DELIVERY
Shriver........	12"	Pl. & Fr.	C.I.	6		Closed
Johnson........	12"	Pl. & Fr	C.I.	32		Open
Shriver........	18"	Recessed	C.I.	26	Center	Open
Shriver........	24"	Pl. & Fr.	C.I.	18	Corner	Open
Johnson........	24"	Pl. & Fr.	C.I.	24	Side	Open
Albright Nell...	24"	Recessed	C.I.	40	Center	Open
Shriver........	30"	Recessed	C.I.	36	Center	Open
Shriver........	30"	Pl. & Fr	C.I.	29	Top	Open
Shriver........	30"	Recessed	C.I.	37	Center	Open
Shriver........	36"	Pl. & Fr.	Rubber Cov	34	Corner	Closed
Sperry........	36"	Pl. & Fr.	C.I.	34	Top	Closed

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475' centers, 18" wide belt, troughing.
300' centers, 18" wide belt, troughing.
29' centers, 18" wide belt, troughing.
96' centers, 30" wide belt, troughing.
50' centers, 42" wide belt, troughing.
Fuller Kinyon 4" Unit.
Apron 36" x 34' centers.
6"x10' Screw, continuous.
9"x10' Screw, sectional.

BUCKET ELEVATORS
70'6" centers, 8"x5" buckets.
64' centers, 10"x6" buckets.
60' centers, 8"x6" buckets.
50'6" centers, 8"x5" buckets.
44' centers, 10"x6" buckets.
44' centers, 15"x12" buckets.
40' centers, 6"x4" buckets.
31' centers, 16"x8" buckets.
23" centers, 8"x5" buckets.
10'8" centers, 6'x4' buckets.

DRYERS
1106-35 Roto-Louvre.
Tunnel Truck 9'x35'x9', cap. 14 trucks.
Turbulaire N2 Spray, with filter.
Stokes, Rotary, Vacuum, 30"x8'.
Vacuum Shelf #11 Devine, 170 sq. ft.
Buflovak 5'x6' Atmos. single drum.
Stokes, 4'x9' Atmos. double drum.

DUST COLLECTORS
4700 CFM, Buell, type AC-130 9½AL (6).
4700 CFM, Buell, type AC-130 9½AL, SS lined (6).
10,000 CFM Birmingham, cyclone.
Schmieg Air Washer.

FEEDERS & SCREENS
Syntron, vibra-flow, type F350.
Jeffrey-Taylor type 4JT 155.
Allis-Chalmers electro magnetic, "Utah."
Fuller 8", star type (2 NEW).
Fuller 12"x13" rectangular.
Tyler-Hummer 4'x7' Vibrating Screen.

FILTERS
36" Shriver Press, washing, closed del., Celoron plates & Frames.
36" open, 27 chambers, wood plates.
30" Sperry, Type 47, 26 chambers.
8'x12' Feinc, all steel.
8'x10' Oliver, wood & steel (3).
11'6"x18' Oliver, all steel.
4'x5' Oliver, SS & wood (2).
#7 Sweetland, 2" spacing, 28 leaves avail.

MILLS
Raymond, 4 roll.
Four cage, Stedman.
5'x22' Smidth, Tube.
6'x8' Patterson, Pebble.
6'x8' Abbe Style GPH, Pebble.
16"x40" Day, 3-roll, Ink.
Abbe Size B Grinding.
Kombinator, Flow Master K Model 200.
L.B. Plug, 2' wide 12' long, double shaft (2).

MIXERS
Paddle, 19"x24"x18", complete w/drive.
Paddle, double shaft, 140 cu. ft. NEW.
Readco 1½ SA, 88 gals.
Blystone 48"x6'7", 500 gals. (2).
Binks, type TM60, 100 gals. (2).
Champion, type E, size 2, 110 gals.
Ajax, #3 Super, 173 gals.
Sublimator, hor., 4'x10'.

KILNS—COOLERS—DRYERS
7'x60'x3/8" with lifters.
6'x14'x9/16" Struthers-Wells (2—NEW).
5'x67'x5/16" with lifters.
4'x34'x5/16" Struthers-Wells.
4'x25'x5/16" brick-lined.
4'x16'x3/8" Iowa with burner & stack.
25"x15'x3/8".
9'6"x85'x3/4".
10'x90'x9/16" Allis Chalmers.
9'6"x8'6"x200'x3/4".
9'6"x84'x3/4".
8'6"x110'x3/4".
12"x27' Sincro Cooler.

PRESSURE VESSELS
8,200 gal. 6'x40'x2", 390 PSI.
3,500 gal. 5'x23"x¾", 200 PSI (4).
2,000 gal. 5'x13'x7½", 106 PSI.
1,250 gal. 4'x14', 106 PSI.
1,200 gal. 42"x16'8"x5/16", 125 PSI, ASME.
1,050 gal. 4'x12'x½", 106 PSI.

TANKS
25,000 gal. 10'x40'x3/8" (2—NEW.)
12,000 gal. 8'x32'x¼" (2—NEW).
8,500 gal. vert. 8'x23'x5/16" (NEW).
4,100 gal. vert. 5'x28"x¼" (NEW).
3,000 gal. 5'x21'6"x¼", type 430 SS.
2,300 gal. 5'x16'x¼", type 304 SS.
2,100 gal. 9'x3'6"x3/16" (2).
1,600 gal. 8'x7'x3/16" (2).
1,100 gal. 5'x7'8"x¼".

TANK CAR TANKS
6,500 gal. 76"x26'7" shell 11/16" & 5/16".

TOWERS
8'x36'x3/8" Absorption (2—UNUSED).
6'x44'x2¼" Scrubber, 5" heads, 225 PSI.
6'x43"x3/8" Bubble Cap. 19 trays.
6'x29'8", Bubble Cap. SS, 21 trays.

MISCELLANEOUS
BLOWERS—From 1000 to 74,000 CFM.
BUILDING—27'x56'x27' clearance, bolted.
CONDENSER—Scraper—8'x15', aluminum.
KETTLES—40 gal. SS. jack't'd, 40# (6).
PUMPS—All sizes & capacities.
PIPE—HAVEG, KARBATE, ALUMINUM.
TABLET PRESSES—Colton.
REDUCERS & VARI-SPEED DRIVES.

PROPANE PLANT
Complete plant. Vaporizing and Mixing Equipment, including 18,000 gallon storage capacity in 3—6000 gal. tanks, ASME Code U69, 200 PSI WP.

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MACHINERY & EQUIPMENT MERCHANTS


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FOR CLASSIFIED INDEX
SEE PAGE 453

Chemical Engineering Reader Service

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Mail the post card below. Before mailing, circle page numbers of items about which you want more details. Then write your name and address on other side of card and mail to us. Your requests will be forwarded to companies concerned, the answer coming direct to you.

TO MAKE IT HANDY

Products and literature in this issue are listed on these pages. There are two indexes. (1) editorial items on new equipment, new products, new literature; (2) products advertised. The index of advertisers is on the proceeding page.

NUMBERS EXPLAINED

Advertisements:—There is a page number on the postcard for each advertisement. Before the number, may appear, L, R, T, B (left, right, top, bottom) locating the ad on the page; small letters following (a, b, c) indicate additional products in the advertisement.

Editorial Items:—Numerials are page numbers; the ABC's distinguish among items where more than one is on a page. There is a number on the postcard for each item in three editorial departments: Equipment News, New Products, and New Literature.

EDITORIAL ITEMS

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3	22	46	66c	86a	104-105a	120-121d	173	205	236b	262a	283	305h	321	342	368b	384c	BL407	R417	R428b
4	23	47	67	86b	104-105b	120-121e	177	210	237	262b	284	306	322	345	369	385	R407	L418	L429
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8b	30-31	54	69d	88c	109d	120-121j	186	218	245	265	B290	B310	327	349a	371d	390b	BL409	R419	BL431
8c	32	55a	69e	88d	109e	120-121k	187	219	247	266-267	291	311	328	349b	371e	391	R409	L420	R431
8d	33a	55b	69f	88e	109f	120-121l	189	220	249	269	292	T312	329	349c	371f	392	L410	R420	TL432
9	33b	55c	69g	88f	109g	122	190	221	T250a	271	293	B312	T330	349d	372	393	TR410	TL421	BL432
10	33c	56-57	69h	88g	109h	123	191	222	T250b	272a	294	T313	B330	350	373-374	394	BR410	BL421	433
11	33d	58	70	88h	109i	124-125	192	223	T250c	272b	295	B313	331	353	375	395	TL411	R421	TL434
12	33e	59	71	88i	109j	126a	193	224	B250	273	296	314	T332	355	376	396	BL411	L422	BL434a
13	33f	60-61	72-73a	88j	109k	126b	197	227a	251	274	297	315	B332	356	377a	397	R411	TR422	BL434b
14a	34	62	72-73b	88k	109l	127	198	227b	253	275a	298	317	333a	357	377b	398	412	L423	435
14b	35	63	74	89	109m	128-129	199a	227c	255	275b	299	318a	333b	358	377c	399	L414	R423a	436
15a	36a	64-65a	75	90	110	130	199b	T228	T256	275c	300	318b	T334	359	378	400	TR414	R423b	437
15b	36b	64-65b	76	91	111	131	199c	B228	B256a	275d	302	318c	B334	360	379a	401	BR414	L424	451a
15c	37a	64-65c	77a	92-93	112-113	132a	200a	T229	B256b	275e	303	318d	335a	361	379b	402	TL415	R424	451b
15d	37b	64-65d	77b	94	115	132b	200b	B229	257	276	305a	318e	335b	362	379c	403	BL415	L425	451c
15e	38	64-65e	78	95	116-117	132c	201a	230	259	277	305b	318f	336	363	380	404	R415	R425	451d
15f	39	64-65f	79	96	118	132d	201b	231a	260a	278	305c	318g	337	364	381	405	L416	L426	451e
16	40-41	64-65g	80-81	97	119	132e	201c	231b	260b	279	305d	318h	338	365	382	TL406	TR416	R426	452
17	42	64-65h	82	98-99	120-121a	132f	202	233	260c	280	305e	318i	339	366	383	BL406	BR416	L427	453
18-19	43	66a	83	100	120-121b	132g	203	235	260d	281	305f	319	340	367	384a	R406	TL417	R427	455
20	44	66b	84-85	105	120-121c	134	204	236a	261	282	305g	320	341	368a	384b	TL407	BL417	R428a	456
21	45																		

Editorial Items

174A	176D	176J	180C	182C	183C	184A	186B	188B	190A	192A	195B	196E	202B	203C	203H	203M	204D	204I	204N
175A	176E	178A	180D	182D	183D	184B	187A	188C	190B	192B	196A	198A	202C	203D	203I	203N	204E	204J	204P
175B	176F	178B	180E	182E	183E	184C	187B	188D	191A	194A	196B	200A	202D	203E	203J	204A	204F	204K	204Q
176A	176G	178C	182A	183A	183F	184D	187C	188E	191B	194B	196C	200B	203A	203F	203K	204B	204G	204L	204R
176B	176H	180A	182B	183B	183G	186A	188A	188F	191C	195A	196D	202A	203B	203G	203L	204C	204H	204M	204S
176C	176I	180B																	

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4	23	47	67	86b	104-105b	120-121e	177	210	237	262b	284	306	322	345	369	385	R407	L418	L429
6	24-25	48-49	68	86c	107	120-121f	179	211	240	262c	285	307	323	L346	370	386	TL408	TR418	R429
6	26	50	69a	87	109a	120-121g	181	212	241a	262d	287	308	325	BR346	371a	387	BL408	BR418	L430
7	27	51	69b	88a	109b	120-121h	183	216	241b	263	289	309	T326	347	371b	389	R408	TL419	R430
8a	28-29	52	69c	88b	109c	120-121i	185	217	243	264	T290	T310	B326	348	371c	390a	TL409	BL419	TL431
8b	30-31	54	69d	88c	109d	120-121j	186	218	245	265	R290	B310	327	349a	371d	390b	BL409	R419	BL431
8c	32	55a	69e	88d	109e	120-121k	187	219	247	266-267	291	311	328	349b	371e	391	R409	L420	R431
8d	33a	55b	69f	88e	109f	120-121l	189	220	249	269	292	T312	329	349c	371f	392	L410	R420	TL432
9	33b	55c	69g	88f	109g	122	190	221	T250a	271	293	B312	T330	349d	372	393	TR410	TL421	BL432
10	33c	56-57	69h	88g	109h	123	191	222	T250b	272a	294	T313	B330	350	373-374	394	BR410	BL421	433
11	33d	58	70	88h	109i	124-125	192	223	T250c	272h	295	B313	331	353	375	395	TL411	R421	TL434
12	33e	59	71	88i	109j	126a	193	224	B250	273	296	314	T332	355	376	396	BL411	L422	BL434a
13	33f	60-61	72-73a	88j	109k	126b	197	227a	251	274	297	315	B332	356	377a	397	R411	TR422	BL434b
14a	34	62	72-73b	88k	109l	127	198	227b	253	275a	298	317	333a	357	377b	398	412	L423	435
14b	35	63	74	89	109m	128-129	199a	227c	255	275b	299	318a	333b	358	377c	399	L414	R423a	436
15a	36a	64-65a	75	90	110	130	199b	T228	T256	275c	300	318b	T334	359	378	400	TR414	R423b	437
15b	36b	64-65b	76	91	111	131	199c	B228	B256a	275d	302	318c	B334	360	379a	401	BR414	L424	451a
15c	37a	64-65c	77a	92-93	112-113	132a	200a	T229	B256b	275e	303	318d	335a	361	379b	402	TL415	R424	451b
15d	37b	64-65d	77b	94	115	132b	200b	B229	257	276	305a	318e	335b	362	379c	403	BL415	L425	451c
15e	38	64-65e	78	95	116-117	132c	201a	230	259	277	305b	318f	336	363	380	404	R415	R425	451d
15f	39	64-65f	79	96	118	132d	201b	231a	260a	278	305c	318g	337	364	381	405	L416	L426	451e
16	40-41	64-65g	80-81	97	119	132e	201c	231b	260b	279	305d	318h	338	365	382	TL406	TR416	R426	452
17	42	64-65h	82	98-99	120-121a	132f	202	233	260c	280	305e	318i	339	366	383	BL406	BR416	L427	453
18-19	43	66a	83	100	120-121b	132g	203	235	260d	281	305f	319	340	367	384a	R406	TL417	R427	455
20	44	66b	84-85	103	120-121c	134	204	236a	261	282	305g	320	341	368a	384b	TL407	BL417	R428a	456
21	45																		

Editorial Items

174A	176D	176J	180C	182C	183C	184A	186B	188B	190A	192A	195B	195E	202B	203C	203H	203M	204D	204I	204N
175A	176E	178A	180D	182D	183D	184B	187A	188C	190B	192B	196A	198A	202C	203D	203I	203N	204E	204J	204P
175B	176F	178B	180E	182E	183E	184C	187B	188D	191A	194A	196B	200A	202D	203E	203J	204A	204F	204K	204Q
176A	176G	178C	182A	183A	183F	184D	187C	188E	191B	194B	196C	200B	203A	203F	203K	204B	204G	204L	204R
176B	176H	180A	182B	183B	183G	186A	188A	188F	191C	195A	196D	202A	203B	203G	203L	204C	204H	204M	204S
176C	176I	180B																	

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10	33c	56-57	69h	88g	109h	123	191	222	T250b	272a	294	T313	B330	350	373-374	394	BR410	BL421	433
11	33d	58	70	88h	109i	124-125	192	223	T250c	272b	295	B313	331	353	375	395	TL411	R421	TL434
12	33e	59	71	88i	109j	126a	193	224	B250	273	296	314	T332	355	376	396	BL411	L422	BL434a
13	33f	60-61	72-72a	88j	109k	126b	197	227a	251	274	297	315	B332	356	377a	397	R411	TR423	BL434b
14a	34	62	72-72b	88k	109l	127	198	227b	253	275a	298	317	333a	357	377b	398	412	L423	435
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175A	176E	178A	180D	182D	183D	184B	187A	188C	190B	192B	196A	198A	202C	203D	203I	203N	204E	204J	204P
175B	176F	178B	180E	182E	183E	184C	187B	188D	191A	194A	196B	200A	202D	203E	203J	204A	204F	204K	204Q
176A	176G	178C	182A	183A	183F	184D	187C	188E	191B	194B	196C	200B	203A	203F	203K	204B	204G	204L	204R
176B	176H	180A	182B	183B	183G	186A	188A	188F	191C	195A	196D	202A	203B	203G	203L	204C	204H	204M	204S
176C	176I	180B																	

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Business Manager..........Albert E. Weis

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